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REMOTE SENSING DATA: APPLICATIONS AND BENEFITS

FIELD HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE AND AERONAUTICS

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

SECOND SESSION

APRIL 7, 2008

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April 7, 2008

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REMOTE SENSING DATA: APPLICATIONS AND BENEFITS

MONDAY, APRIL 7, 2008

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON SPACE AND AERONAUTICS,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10 a.m., at Centennial Hall, 200 South Cascade Avenue, Colorado Springs, Colorado, Hon. Mark Udall [Chairman of the Subcommittee] presiding.

COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SPACE & AERONAUTICS
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, DC 20515

Field Hearing on

Remote Sensing Data: Applications and Benefits

April 7, 2008
10:00 a.m. – 12:00 p.m.
Centennial Hall
Colorado Springs, Colorado

WITNESS LIST

Panel 1
Mr. Jack Byers
Deputy Director and Deputy State Engineer
Colorado Division of Water Resources

Dr. Simon Montagu
Customer Resource and Support Director
Denver Regional Council of Governments

Mr. Manuel Navarro
Fire Chief
City of Colorado Springs

Mr. Frank Sapio
Director
Forest Health Technology Enterprise Team
U.S. Department of Agriculture Forest Service

Panel 2
Mr. Kevin Little
Director of Business Development
Intermap Technologies, Inc.

Mr. Matthew O'Connell
President and CEO
GeoEye, Inc.

Ms. Jill Smith
President and CEO
DigitalGlobe, Inc.

FIELD HEARING CHARTER

SUBCOMMITTEE ON SPACE AND AERONAUTICS
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

Remote Sensing Data: Applications and Benefits

MONDAY, APRIL 7, 2008
10:00 A.M.–12:00 P.M.
CENTENNIAL HALL
200 S. CASCADE AVENUE
COLORADO SPRINGS, COLORADO

Purpose

On Monday, April 7, 2008 at Centennial Hall, Colorado Springs, Colorado at 10:00 a.m.–12:00 p.m., the House Committee on Science and Technology, Subcommittee on Space and Aeronautics will hold a hearing to examine the opportunities and challenges of using remote sensing data to benefit public and private sector activities including urban planning, natural resource management, national defense, and homeland security among other application areas.

Witnesses:

Witnesses scheduled to testify at the field hearing include the following:

Panel 1: Remote Sensing Data Users

Jack Byers, Deputy Director and Deputy State Engineer, Colorado Division of Water Resources

Simon Montagu, Customer Resource and Support Director, Denver Regional Council of Governments

Manuel Navarro, Fire Chief, City of Colorado Springs

Frank Sapio, Director, Forest Health Technology Enterprise Team, U.S. Department of Agriculture Forest Service

Panel 2: Commercial Remote Sensing Data Providers

Kevin Little, Director, Business Development, Intermap Technologies, Inc.

Matthew O'Connell, President and Chief Executive Officer, GeoEye, Inc.

Jill Smith, President and Chief Executive Officer, DigitalGlobe, Inc.

Data and images collected from aircraft and satellites provide information that can facilitate public and private operations and decision-making to benefit society. In the aftermath of the terrorist attacks on September 11, 2001, remote sensing images acquired from aircraft and from commercial and government remote sensing satellites aided in the emergency response and recovery operations at Ground Zero. Commercial remote sensing imagery has also been used by the U.S. military for the Afghanistan and Iraq wars. In August of 2007, a National Aeronautics and Space Administration (NASA) unmanned aerial vehicle used an infrared scanner to map wildfires in the western U.S. Data from Earth-observing satellites are being combined with sources of information on the ground to manage natural resources and monitor changes in land and Earth systems. Aerial photography and images acquired from satellites are used by State and local governments to map flood plains and natural resources, among other applications.

The field hearing will address the opportunities and challenges of using remote sensing data to address public and private sector needs. Witnesses will testify on the ways that remote sensing data can assist public and private sector users in Colorado, for instance, in identifying forests vulnerable to fire and insect infestation, managing water resources, planning urban development and road construction, and mapping flood plains. Commercial providers of remote sensing data will testify on the benefits of remote sensing data to State and local governments and on the role

that commercial data can play in addressing these civil applications as well as those related to homeland security and national defense.

BACKGROUND

The ability to collect information and images of the Earth's land, atmosphere, and oceans from aircraft and satellites has been available for decades. The use of aerial photography grew during the 1930s and 1940s as a means of military reconnaissance. The first U.S. meteorological satellite was launched in 1960 and the first U.S. civil satellite to observe and monitor the land surface, Landsat, was launched in 1972. Over the last forty years, the U.S. Government has helped advance the state of civil space-based remote sensing. Through NASA and the National Oceanic and Atmospheric Administration (NOAA), the U.S. Government has launched an ongoing series of increasingly more capable Earth-observing satellites to support an operational weather monitoring service and to conduct research to better understand the Earth's land, ocean, atmosphere, and biosphere, their relationships, and how the Earth system changes over time. In addition, the U.S. Geological Survey has been responsible for archiving and managing civil land remote sensing data. The *Land Remote Sensing Policy Act of 1992* set commercial land remote sensing as a U.S. policy goal and included a process to license private remote sensing satellite operators. In the early 1990s the first licenses were issued to private remote sensing operators and by 1999 the first commercial remote sensing satellite was launched.

The advantages of remote sensing include the ability to collect information over large spatial areas; to characterize natural features or physical objects on the ground; to observe surface areas and objects on a systematic basis and monitor their changes over time; and the ability to integrate this data with other information to aid decision-making. Remote sensing from airplanes or satellites can be collected at various spatial resolutions [spatial resolution refers to the smallest feature that can be resolved in an image]. High resolution remote sensing images can resolve smaller features—often less than a meter in size—whereas moderate or lower resolution images can detect features in a size range of tens to hundreds of meters or larger. Remote sensing instruments may also acquire data in different spectral bands of the electromagnetic spectrum (e.g., infrared, near-infrared), which provides information, for example, to help classify and categorize vegetation. Data collected in the thermal infrared bands are especially useful for water management. Light detection and ranging (lidar) instruments provide topographic data that can form the basis of digital elevation models.

The needs of local government often require high resolution data, which has long been provided through aerial imagery. The advent of commercial high resolution remote sensing imagery in the late 1990s created another source of data that can serve local and regional governments. In addition, States have taken advantage of moderate resolution U.S. Government-provided Landsat data to monitor natural resources, such as forests and wetlands that span large areas, to analyze the ecological systems of land and watershed areas, and to help protect wildlife habitats.

State and local governments can also benefit from remote sensing information to better monitor land use, assist in transportation planning, and deal with other infrastructure and public safety issues. In addition, commercial enterprises use the data to help support their businesses. For example, real estate companies use imagery to enhance the information provided on real estate property listings, and transportation companies may use remote sensing data to help route trucks.

Providers of remote sensing data

Remote sensing data for State and local applications is provided by both U.S. Government agencies and by commercial providers. Landsat satellites, which have been developed and launched by NASA since 1972, are operated by the Department of Interior's U.S. Geological Survey (USGS) and the data are archived and managed by the USGS Center for Earth Resources Observation and Science (EROS) Data Center. The USGS manages and archives publicly available aerial photographs and lidar data, among other data sets. The USGS has responsibility for providing future space-based land observation data after NASA's launch of the Landsat Data Continuity Mission, which is planned for 2011.

NASA operates fourteen Earth-observing research satellites from space to further our knowledge of the Earth system, including its atmosphere, oceans, land surface, and biosphere. Some of these spacecraft support applied uses by public and private organizations. The Terra and Aqua satellites, for example, collect data that support fire monitoring and the Quick Scatterometer (QuickSCAT) and Tropical Rainfall Measuring Mission provide data to help improve tropical cyclone and hurricane fore-

casting. In addition, within NASA's Earth Science Division, the Applied Sciences Program works with federal agency partners and other organizations to apply NASA's Earth remote sensing data to decision support tools in the areas of agricultural efficiency, air quality, aviation, carbon management, coastal management, disaster management, ecological forecasting, energy management, homeland security, invasive species, public health and water management. Many of the agencies and organizations that use these tools provide services that extend to the State, local, and regional levels.

The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) operates the Nation's fleet of civil operational weather monitoring satellites, which provide data to inform the National Weather Service's forecasts. Future satellite systems in which NOAA is involved, including the National Polar-orbiting Operational Environmental Satellite System (NPOESS), will also collect global data on the Earth's weather, oceans, land and space environments. NOAA also operates data centers that archive geophysical, climate, ocean, and coastal data and provide information products to support scientific research and other purposes.

Multiple independent firms across the country provide services to collect aerial photography. Federal agencies also collect aerial imagery to support their services. United States commercial space remote sensing companies operate satellites and sell imagery and applications to customers in the public, private, and non-government sectors. The market for commercial remote sensing data has largely been in high resolution imagery. The Department of Defense has been a major user of commercial remote sensing imagery. Commercial remote sensing companies support applications including mapping, national security, environmental monitoring, urban planning, natural resource management, homeland defense, and emergency preparedness and disaster relief, among many other areas. Several non-U.S. companies also collect and sell space remote sensing data.

Digital information and communications technologies

The increasing capabilities of computers and communication technology have facilitated the development of remote sensing applications. Digital remote sensing data can be acquired from and disseminated over the Internet, and manipulated on desktop computers. Geographic information systems enable multiple sources of geographic information (such as locations of power plants and hospitals) to be integrated with remote sensing images. Global positioning data can be combined with remote sensing data sources to enable applications that rely on accurate locational information. In addition, software tools allow multiple sources of remote sensing data to be blended together to maximize the information content for remote sensing applications.

The availability of civil remote sensing data has led to the establishment of companies dedicated to processing and transforming remote sensing data into information products and applications for users. These companies create mapping products, such as topographical line maps and digital elevation models, three-dimensional visualization tools, among other remote sensing applications.

Chairman UDALL. This hearing will come to order. Good morning to all of you. I want to welcome the panel witnesses that we have, a very esteemed and erudite group that we're going to hear from in a few minutes. In particular, I'm pleased that my colleague and Ranking Member on the Space and Aeronautics Subcommittee, Representative Tom Feeney from the great State of Florida has been able to join me here in our great State of Colorado.

I have to tell you as an aside that Congressman Feeney is a very committed aerobic athlete. He got up this morning and ran five or six miles here in Colorado, which is really impressive given that he's a flatlander and came from Florida just yesterday.

I'd also like to mention that Congressman Lamborn, who represents Colorado in the United States House of Representatives, he does send his regrets. He would have liked to have joined us here today, but he unfortunately had a previous commitment that made that impossible.

Before we begin, I'd like to also take the opportunity to recognize some of the local officials who are here and thank El Paso County officials for their help with today's hearing. I'm looking forward to today's hearing because it touches on an area that has great relevance for the lives of citizens here in Colorado, as well as for the lives of folks all across America. It's an area that hasn't gotten as much public attention as it deserves, especially relative to the impact it has had on the operations of our State and local governments, as well as on other public and private-sector activities in Colorado and elsewhere. I am speaking, of course, of the way that remote sensing data collected from commercial and government spacecraft and aircraft have been used to provide societal benefits, help strengthen our national defense, and protect our homeland.

And we are in an appropriate place to discuss these issues as Colorado is leading the way in remote sensing technology. Not only is our State the center of gravity for commercial remote sensing activity, but our State and local government officials are also on the cutting edge of using this technology to help Colorado citizens. But I don't want to give too much away from our witnesses' testimony today.

I would like to note that we've come a long way since some of the first aerial photographs were taken of Boston in 1860 from a tethered balloon and even from the first civil remote sensing satellite, TIROS 1, which was launched a century later in 1960 to take images to be used in weather forecasts. Today, remote sensing data is becoming nearly ubiquitous through the use of advanced satellite, computing and communications technologies. One need only call up web-based tools to access images of cities, neighborhoods and unpopulated areas across the country at no cost.

The U.S. Government and commercial firms operate numerous aircraft and satellites to collect and deliver the remote sensing data to users on the ground. Today we will hear more about how these data are used to benefit our society, and what needs to be done to expand on the opportunities this information offers.

We need not look far to see and feel the challenges, some known and some unknown, facing our municipalities and our nation. Rising energy costs, our scarce water supply, and urban sprawl are complex problems. We need to bring to bear the best available in-

formation to ensure that we take effective and well-informed actions in response. Moreover, our natural environment and resources demand our vigilant stewardship. We depend on water, forests, and fertile land, among other resources, to support our needs.

Here in Colorado, we have a close relationship with the land around us and are even more aware of how vulnerable these resources are. Drought, the pine beetle infestation, and fire have wreaked havoc on our communities and our environment. I hope our witnesses can give us insight into how remote sensing data can be used to help us effectively manage our natural resources. Our government and private institutions also need to ensure that we are prepared in the event of emergencies and crises.

The tragedy of September 11, 2001 brought into stark reality the need to assess our infrastructure and plan against the risks. Remote sensing was a vital asset in the response and recovery efforts at Ground Zero. I'm very interested in learning about how remote sensing data can help our State, local and federal agencies ensure our security at home and abroad as well as respond to emergency situations.

Our witnesses today will also discuss the role of commercial and remote sensing in collecting and delivering the data to meet the needs of both public and private sector customers. There is a science and an art involved in turning the data collected by remote sensing instruments into sophisticated tools to support decision-making, and I hope our witnesses will help us learn about the range and types of products that are available.

In that regard, I want to add that as an avid skier, Tom, I was pleased to learn the Colorado hosts a company [SnowVisual, Inc. of Vail] that specializes in the use of satellite imagery to support the snow sports industry. I consider that a true public service.

Congress has continued to provide policy direction for civil and commercial remote sensing to ensure the continued availability of this important data. The *Land Remote Sensing Policy Act of 1992* called for the continuity of civil land remote sensing data and established the guidelines to enable commercial operation of space remote sensing satellites.

In addition, Section 313 of the *NASA Authorization Act of 2005* directed NASA to support the pilot projects "to explore the integrated use of remote sensing and other geospatial information to address State, local, regional, and other tribal agency needs." As we work on reauthorizing NASA this year, I intend to explore whether Congressional legislation has been effective in addressing those objectives, and whether Congress needs to consider additional measures to enable the expanded use of remote sensing data and information.

I hope that this hearing will help us also understand how we can continue to improve the delivery of these data to users so that it can be coordinated and shared among local, State, and federal institutions, especially in the event of a crisis. Finally, I look forward to hearing from our witnesses regarding what, if anything, needs to be done to sustain and grow a robust commercial remote sensing industry in the United States.

Well, we've got a great deal to discuss today, and we have a very capable set of witnesses before us. Before we begin with today's

witness, I would like to note that while today's hearing is focussed on uses of remote sensing data, Colorado is home to several outstanding companies that design, build and manage critical sensors to collect this information, including Lockheed Martin, Ball Aerospace, and ITT. Without their excellent sensor systems, our companies here today would not have much to work with. So I acknowledge their critical role in this area and am pleased that several representatives from these companies are here today and will be submitting testimony for the record.

In closing, I again want to thank all of our witnesses for participating in today's hearing, and I look forward to your testimony.

[The prepared statement of Chairman Udall follows:]

PREPARED STATEMENT OF CHAIRMAN MARK UDALL

Good morning. I want to welcome everyone to this morning's hearing.

In particular, I'm pleased that my colleague and Ranking Member on the Space and Aeronautics Subcommittee, Rep. Tom Feeney, has been able to join me here in the great State of Colorado.

I'd also like to mention that Rep. Doug Lamborn, who represents Colorado Springs in the U.S. House of Representatives, sends his regrets.

He would have like to have joined us here today, but unfortunately he has a previous commitment that made that impossible.

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I want to learn about how remote sensing data can help our State, local, and federal agencies ensure our security at home and abroad as well as respond to emergency situations.

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There is a science and art involved in turning the data collected by remote sensing instruments into sophisticated tools to support decision-making, and I hope our witnesses will help us learn about the range and types of products that are available.

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In addition, Section 313 of the *NASA Authorization Act of 2005,* which I helped enact, directed NASA to support pilot projects "to explore the integrated use of . . . remote sensing and other geospatial information to address State, local, regional, and other tribal agency needs."

As we work on reauthorizing NASA this year, I intend to explore whether Congressional legislation has been effective in addressing those objectives, and whether Congress needs to consider additional measures to enable the expanded use of remote sensing data and information.

I hope that this hearing will also help us understand how we can continue to improve the delivery of these data to users so that it can be coordinated and shared among local, State, and federal institutions—especially in the event of a crisis.

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Without their excellent sensor systems, our companies here today would not have much to work with!

So I acknowledge their critical role in this area and am pleased that several representatives from these companies are here today and will be submitting testimony for the record.

In closing, I again want to thank all of our witnesses for participating in today's hearing and I look forward to your testimony.

Chairman UDALL. The Chair now recognizes Mr. Feeney for an opening statement.

Mr. FEENEY. Well, thank you, and I'm delighted, Mr. Chairman, to be in your home state. It's a great pleasure to be here. You did point out that I try to run every morning. The good news is this morning I ran from the Broadmoor uphill, because if I had started out downhill, I wouldn't have made it back and would be out there wandering around breathlessly. But I made it back, and I was inspired by the view and really enjoyed it.

I want to also thank our witnesses for taking time out of their busy schedules to share their wisdom and concerns regarding the

benefits, future roles, and challenges confronting this increasingly essential capability we're talking about today.

It wasn't too long ago that remote sensing data was largely a product of cameras and other sensors carried on aircraft. But with the advent of the government- and commercial-owned remote sensing satellites and their growing capabilities, and with the ability to fuse databases, today's marketplace offers a dynamic and sophisticated array of products.

Remote sensing data provide essential tools that help local and regional government planners develop a comprehensive and dynamic view of their communities and lands. They enable the capability to monitor and measure the impacts and threats to agricultural and urban activities, such as measuring soil moisture, water use, pest infestation, and land development. Equally important, at the local level remote sensing data has fast become critical to the delivery of emergency services.

One thing Florida and Colorado share now and then is the threat from things like wildfires, and I look forward to hearing how the many states and regions that are impacted by that threat can be assisted by the technology. Nationally, remote sensing data provides critical information used to monitor and predict weather and climate change—again, Florida has our own share of climate change—land use changes at a macro scale, and monitor and protect our borders.

This morning our witnesses will provide compelling testimony highlighting the utility of remote sensing data. In reading over the witnesses' testimony, I was particularly fascinated by the capabilities developed by emergency response personnel to devise plans and methods to deal with threats to our communities, as well as assuring rapid first-response services. As cities grow in size, timely delivery of these services becomes more complex, and being able to quickly target police, paramedic and fire services all the more critical.

While today's hearing will be Colorado industry focused, I can tell you that in my Congressional District along Florida's Space Coast, we've experienced a dramatic rise in population over the last two decades. As a consequence of this growth, ensuring timely emergency response services, measuring land-use impacts, and preserving adequate fresh water sources are considerations that now control much of our future development considerations.

With that, Mr. Chairman, I again want to thank you and your staff for your hospitality. I am excited to hear from our witnesses and look forward to a good hearing.

Chairman UDALL. Thank you, Mr. Feeney.

[The prepared statement of Mr. Feeney follows:]

PREPARED STATEMENT OF REPRESENTATIVE TOM FEENEY

Mr. Chairman, it's a genuine pleasure to be here in Colorado to conduct this hearing on the opportunities and challenges of using remote sensing data. I want to join with you in thanking our witnesses for taking time out of their busy schedules to share their wisdom and concerns regarding the benefits, future roles, and challenges confronting this increasingly essential capability.

It wasn't too long ago that remote sensing data was largely a product of cameras and other sensors carried on aircraft. But with the advent of government- and commercial-owned remote sensing satellites and their growing capabilities, and with the

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While today's hearing will be a bit Colorado-centric, I can tell you that in my congressional district along Florida's space coast, we have experienced a dramatic rise in population over the last two decades. As a consequence of this growth, ensuring timely emergency response services, measuring land-use impacts, and preserving adequate fresh water sources are considerations that now control much of our future development.

With that, Mr. Chairman, I want to thank again our witnesses for their presence, and I look forward to their statements.

Chairman UDALL. And we'll do a little bit of housekeeping here. If there are Members of our subcommittee that are not here, Members who wish to submit additional opening statements, their statements will be added to the record. Without objection, so ordered.

Panel 1:

Chairman UDALL. Let me move to introduction here of the first panel of the witnesses, and I'd like to recognize each of you in turn, and we'll come back to Mr. Byers to begin testimony. We are joined by Mr. Jack Byers, who is the Deputy Director and the Deputy State Engineer for the Colorado Division of Water Resources. To his left is Dr. Simon Montagu, who is the Customer Resource and Support Director for the Denver Regional Council of Governments, also know as DRCOG, fondly so. Next to Dr. Montagu is the Fire Chief, Mr. Navarro. He's the Fire Chief of the City of Colorado Springs Fire Department. We just saw each other last week in Washington. And finally, next to Mr. Navarro, we have Mr. Frank Sapio who is the Director of the U.S. Department of Agriculture's Forest Service, Forest Development Technology Enterprise Team.

Welcome to all of you. We have some great expertise in front of us. I think you all know, as witnesses, that your spoken testimony is limited to five minutes, and after which Members of the Subcommittee will have five minutes each to ask some questions and further draw out the expertise that's in front of us.

So we'll start with Mr. Byers. Mr. Byers, the floor is yours.

STATEMENT OF MR. JACK G. BYERS, DEPUTY DIRECTOR AND DEPUTY STATE ENGINEER, COLORADO DIVISION OF WATER RESOURCES

Mr. BYERS. Thank you Chairman Udall, Congressman Feeney. I really appreciate the opportunity to be here. And as the first wit-

ness, I guess I'm a native of Colorado. Welcome to Colorado Mr. Feeney, and welcome back. We appreciate having you here.

My name is Jack Byers, for the record. I'm the Deputy Director and Deputy State Engineer for the Colorado Division of Water Resources and I'm submitting this testimony on behalf of the State of Colorado.

I want to point out that we are providing testimony that's relatively focused today. It does not mean that we aren't interested in other areas or that we don't support the other expertise and information being provided today. We have what we think is a significant need that we wanted to bring to the Subcommittee's attention.

The other thing I'd like to mention is, although it was clear skies here today, to the north we had some snow. We appreciate that very much, and our snow pack is over 100 percent, which for us is a big deal, and skiing is tremendous. So if you'd like to stay longer, we'd be happy to have you ski.

Mr. FEENEY. I just might have to take you up on that.

Mr. BYERS. That would be very good. As I mentioned today, we are providing testimony on a fairly focused area. The State of Colorado and many other western states have a critical need for high-resolution, thermal and infrared remote sensing. This is a particular remote sensing.

Colorado and other water agencies are actively integrating thermal, infrared and remote sensing techniques as their management strategies to estimate actual crop evapotranspiration. That's with combined plant and surface evaporation, to classify land covered by vegetation types and quantify water consumption by irrigation, to support transfer of agricultural water to growing cities, and I should say that in a limited area. Here in Colorado, we do a great deal of work at trying to limit those impacts, and we do following programs and such, but we do know that there will be a transfer of water here in Colorado from irrigated agriculture to the growing cities. And this particular technology helped us a great deal in working with that.

We use infrared remote sensing for estimating aquifer depletion, river and canal transport modules, water rights, compliance with water rights as well as water modeling, and most important, climate change initiatives and the scheduling of irrigation diversions.

This satellite-based information is highly beneficial in terms of efficient water management. And I might add that much of this is interstate compact water management, Colorado River Basin water management. The Colorado River Basin, of course, is not just a Colorado issue that you'd have Wyoming, Utah, Arizona, and New Mexico, Nevada, and I believe there's a western state, California, that has a great interest in Colorado water, Colorado River Basin water.

As you know, NASA launched the first Landsat satellite in 1972. Landsat has the world's longest, continuous program to collect digital, multispectral data of the Earth from space. LANDSAT 4, launched in '82, was the first LANDSAT series to carry thermal imagery, and each successive LANDSAT has had the thermal infrared remote sensing capability.

Currently, we have some difficulties. It's available only on Landsat 5 and Landsat 7. I won't bore you with the details, but I will say that if we aren't able to, with our next continuation of Landsat, carry this camera and this imaging, it could be extremely detrimental to westwide water management. I know that you're aware that the Western States Water Council has also taken the position that this is critical, and Colorado joins the other western states in again reminding the Subcommittee that this is very important to us in Colorado as well as the west.

I want to point out a couple of key issues that we had here in Colorado, and that is that I mentioned our snow pack is very good this year. It hasn't been that good in the past. And when we have to manage ground and we look at the Colorado River Basin and the potential of climate change, climate adaptation. In this infrared technology, the imaging is extremely critical. So it is a real westwide issue. I might also say that it helps us with the evaluation of the impact of changing water and land uses on wetlands, fish and wildlife, and endangered species, another key area that Colorado would like to continue to work with.

Being a native of Colorado and knowing that time is short, I'm not one to talk a whole lot. And in conclusion, I just want to say that Colorado strongly supports NASA's spending for the thermal sensor on Landsat. And we don't believe that the addition of a thermal sensor on Landsat will make a significant difference in the scheduling. I have over 30 years of federal service, both State and Federal Government, and with tribes, and I would be extremely surprised if NASA put this satellite up on time and on schedule. Therefore, I think that the addition of this unit would not significantly deter that mission.

We're thankful for Chairman Udall, your support. We also have a great deal of support from the other Congressional delegation within Colorado. We thank them. Congressman Feeney, we'd like to count you toward that support as well to work toward the resolution of what we think is a critical problem. Again, short testimony, and I'd be happy to answer any questions.

Chairman UDALL. Thank you, Mr. Byers.

[The prepared statement of Mr. Byers follows:]

PREPARED STATEMENT OF JACK G. BYERS

Hon. Mark Udall, Chairman and Members of the Subcommittee:

My name is Jack Byers, Deputy Director and Deputy State Engineer for the Colorado Division of Water Resources. I am submitting this testimony on behalf of the State of Colorado.

The State of Colorado and many other western states have a critical need for High Resolution Thermal Infrared Remote (TIR) Sensing. Colorado and many western water agencies are actively integrating Thermal Infrared Remote (TIR) remote sensing techniques into their management strategies to estimate actual crop evapotranspiration (ET), to classify land cover by vegetation (crop) type, to quantify water consumption by irrigation to support transfer of agricultural water to growing cities and other uses, for estimating aquifer depletion and river/canal transport losses, monitoring water-rights compliance, water modeling, climate change initiatives and for scheduling irrigation diversions and reservoir releases. For these applications, replacing on-the-ground reconnaissance with satellite-based information is highly beneficial in terms of efficient water management, efficient use of limited resources and improved decision-making.

As you know NASA launched the first Landsat satellite in 1972, which makes Landsat the world's longest continuous program to collect digital multi-spectral data

of the Earth from space. Landsat 4, launched in 1982, was the first of the Landsat series to carry a thermal imager, and each successive Landsat has had a thermal infrared remote (TIR) sensing capability.

High resolution TIR (approximately 60 m to 120 m pixel resolution) is needed for the water resources management activities identified above. The quantification of water use from Landsat using thermal data is the only way to independently and consistently measure water use on a field-by-field basis over large land areas. Typical field sizes in the U.S. range from 10 to 160 acres, or about 180 meters to 750 meters on a side. These sizes require relatively high resolution images to produce information on an individual field. Other satellite platforms [MODIS, (Moderate Resolution Imaging Spectroradiometer), ASTER, (Advanced Spaceborne Thermal Emission and Reflection Radiometer), AVHRR, (Advanced Very High Resolution Radiometer), GOES, (Geostationary Operational Environmental Satellites), NPOESS National Polar-orbiting Operational Environmental Satellite System)] include TIR capability but at insufficient resolution to be useful at the field scale level, or with inadequate return times or communication down-link constraints.

Irrigation is the largest user of fresh water in the western U.S., and Landsat thermal data is the basis of the best and least expensive way to quantify and locate where water is used and in what quantity. The 20+ year record of continuous high resolution TIR data on future Landsat satellite missions or other platforms is uncertain. Landsat 8 scheduled to launch in 2011 does not contain a thermal imager. The Landsat Data Continuity Mission (LDCM) also doe not currently contain specification of a high resolution TIR.

Irrigated agriculture accounts for 80–85 percent of the consumptive water use in the West. Increasingly Western States use TIR data to observe land-surface temperature and energy balance differences from evapotranspiration (ET) and calculate water consumption by agriculture and other vegetation. Without FY 2008 funding, a TIR sensor likely cannot be built in time to meet the 2011 launch timeline and this increasingly valuable data will be lost. Use of TIR data for water management has only recently exploded, following a drop in the cost of the data after a failed attempt at private commercialization. Landsat 5 and Landsat 7 are the only U.S. sources of this data, but Landsat 5 is nearly 20 years beyond its design life and Landsat 7 equipment failures have left data gaps. Landsat 6 was destroyed when its launch failed. No other U.S. or foreign TIR remote sensing capabilities now, nor for the foreseeable future, can provide the workable features which now allow a growing number of data users to measure and monitor water use.

Currently, higher resolution TIR is available only on Landsat 5 and Landsat 7. Landsat 7 data after 2003 are difficult to use operationally due to failure of the scan-line corrector. Landsat 5 launched in 1984 is 24 years old and has had power problems. The satellite was temporarily taken out of service in October 2007 following a cell failure within one of the satellite's two operating on-board batteries. The USGS announced on Feb. 29, 2008 that Landsat 5 is once again collecting and down-linking land-image data.

Demonstrated water resources planning and management applications include:

- quantifying and monitoring consumptive water use by irrigated agriculture, urban and suburban landscapes, and natural vegetation,
- estimation of transferable water due to land fallowing,
- calibrating ground water models,
- monitoring aquifer depletion,
- computing water budgets for surface water models,
- compliance with limits on water consumption under interstate compacts,
- monitoring the uniformity of irrigation water application,
- crop area, type, pattern and yield estimation,
- monitoring the exercise of water rights, in order to ensure their use according to State and federal laws, decrees, compacts and negotiated agreements, rules and regulations.

The availability of thermal data from satellites, especially Landsat, has enabled the development of energy balance models that compute and map actual crop evapotranspiration (ET). Evapotranspiration is a term used to describe the sum of evaporation and plant transpiration from the Earth's land surface to atmosphere. Evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and water bodies. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves. Evapotranspiration is an important part of the water cycle.

This application is the first important use of Landsat thermal data, and it has the clear potential grow dramatically.

- ET mapping has been accomplished using the SEBAL (Surface Energy Balance Algorithms for Land) and METRIC (Mapping ET at high Resolution using Internalized Calibration) models in Idaho, Utah, Wyoming, Montana, Washington, New Mexico, Texas, Nevada and California. ET from individual fields is estimated for purposes of water rights and irrigation water management. The use of METRIC, SEBAL and other processes that rely on Landsat's visible, near infrared, and thermal data, are substantially more accurate than are simpler ET methods that use vegetation indexes, which are a combination of the visible and near infrared spectrum only. The advantage of using thermal data in mapping water use is that land surface temperature can identify fields that are short of water and thus have suppressed ET. This information is important to quantify actual water use by both irrigated agriculture and urban landscaping.
- In Colorado, Colorado State University has developed and applied its own version of the surface energy balance model using TIR data, RESET (Remote Sensing of ET), in the lower South Platte and Arkansas River Basins. Satellite based crop ET estimates will allow the direct estimation of actual crop ET when crops are stressed by lack of water, salinity, or other stress factors. The ability to continue the development and use of models like RESET will be an important complement to the detailed crop ET/lysimeter research being initiated in the Arkansas Valley and supported by DWR.

Data on cropped area/acreage and classification by crop type are periodically updated for use in hydrologic models used to determine compliance with interstate compacts, such as the H–I Model in the Arkansas River Basin. Three remotely sensed Landsat imagery bands are needed in this crop classification work: the visible, near-infrared and thermal. All three bands are used to identify unique crop signatures. The loss of the thermal band would seriously impact this work effort and require greater expenditure of resources in ground-truthing of the remotely sensed estimates. Additionally, the high resolution imagery allows crop and field identification at the scale of most fields in the Basin, with potential several pixels per field.

Colorado joins the Western States Water council and other western states in strong support of increased funding for the National Aeronautics and Space Administration (NASA) Earth Systematic Missions Program and Landsat 8 thermal infrared (TIR) imaging technology needed to better manage water use. This data has been provided since 1982, from NASA Landsat satellites. The Administration has not requested NASA FY 2008 funding for a TIR sensor on Landsat 8, scheduled to be launched in 2011. The total estimated cost is $90–$100 million, with $35 million needed in FY 2008.

At present, TIR data is used for defining field boundaries, crop-type and water consumption in Colorado, California, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, Texas, Utah, Washington and Wyoming, while other states are considering its future use. Related activities have been undertaken or proposed in the Arkansas, South Platte, Bear, Boise, Upper and Lower Colorado, Lemhi, Milk, North Platte, Upper and Middle Rio Grande, Russian, Salmon, San Juan, Snake, and Yakima River Basins. This important data gathering tool is now used or can be used in the future for or to:

- Calculate water use on a field-by-field and regional scale and encourage water conservation;
- More accurate water supply and demand planning, including multi-basin water balances and budgets;
- Measure consumptive use of surface and ground water resources and impacts of diversions/pumping;
- Administer water rights and evaluated proposed uses, changes in use and water right transfers;
- Ensure compliance with interstate compacts, international treaties and other water use agreements;
- Plan, mitigate and respond to drought, wildfire and other heat-related events;
- Monitor and assess the impact of climate change on water, wetlands, vegetation, land uses, etc.;
- Evaluate the impact of changing water/land uses on wetlands, fish, wildlife, and endangered species; and

- Many other natural resources, emergency management, military, and other uses of national interest.

The 2000 Census reported that one third of all Americans live in the West, and that the West accounted for half of the overall U.S. population growth over that decade. The arid U.S. West is experiencing explosive population growth. As Colorado and the West grows, water conservation is key, the increased demand for scarce water supplies has shifted water management strategy to developing innovative concepts for sustainable use, developing more effective methods to allocate limited water supplies. Water resources managers must understand water consumption patterns over large geographic areas; Landsat provides an important tool for effective, sustainable water management.

Colorado is involved in the allocation and administration of water rights, Interstate compact compliance and planning for future water needs related to population growth. For example, in the Colorado River Basin, which supplies the myriad water needs of millions of people in seven western states, ongoing discussions over sharing water shortages and balancing future needs depend to a large extent on measuring and monitoring consumptive water use governed by international treaties, interstate compacts and State and federal laws. Landsat thermal imagery is a tool with the potential to help smooth the way towards a present and future water rights balance.

There are many other examples of such uses or potential uses of Landsat TIR imagery in water management in the West. In California, Landsat data and ET-related information help farmers determine their actual irrigation needs. In New Mexico, Landsat data and ET maps are helping water managers strike a balance between irrigation demands and riparian vegetation, as well as the habitat needs of endangered species. In the State of Washington, water users have used ET estimates, again derived from Landsat thermal data, to encourage conservation of water resources and increase streamflows for fish while maintaining crop production and farm income. Colorado, Kansas and Nebraska are exploring the use of Landsat data and ET to better monitor and manage ground water uses in order to control overdrafting. Montana uses Landsat data for water quality monitoring. Wetlands delineation, habitat identification and soil moisture monitoring are other Landsat uses.

In conclusion, Colorado strongly supports NASA spending for the thermal sensor on Landsat 8 and urges the Subcommittee to remedy this critical omission. We are thankful that Congressman Udall, Senators Allard and Salazar, as well as others in the Colorado delegation and west-wide continue to work toward resolution of this critical problem. I would be happy to answer any questions or provide any further information the Subcommittee might request.

Thank you for the opportunity to submit this testimony.

BIOGRAPHY FOR JACK G. BYERS

Jack Byers is the Deputy Director and Deputy State Engineer for the Colorado Division of Water Resources. Responsible for the leadership and management of the Intrastate Water Supply, Development and Public Safety which includes the Engineering, Technology and Investigations Division, Water Supply and Well Permit Division and Budget management office. Jack oversees the safety of dams program, hydrographic and Stream measurement program, well construction programs and the enforcement and compliance with applicable decrees, statutes, rules and regulations. He serves on the National Dam Safety Review Board, Dept. of Homeland Security—Government Coordinating Council on Dam Security, Co-Chair of the Governor's Water Availability Task Force, and serves on the Governor's flood hazard mitigation task force, Colorado homeland security task force, and provides technical support to the Colorado Commission on Indian Affairs. Jack also is the co-author of the *Colorado Water Law Benchbook.* Jack is a Colorado native, with a BS in Civil Engineering and a MS in Water Resources, Geotechnical and Structural Engineering from Kansas State University. A Licensed Professional Engineer in Colorado and Montana. Prior to the State of Colorado he was the Director for Indian Affairs and Wyoming Office State Manager for MSE Inc. He also worked 18 years with the U.S. Bureau of Reclamation in a variety of management and leadership positions in Denver, CO; Bismarck, ND and Billings, MT.

Chairman UDALL. Dr. Montagu.

STATEMENT OF DR. A. SIMON MONTAGU, DIRECTOR, CUSTOMER RESOURCE AND SUPPORT, DENVER REGIONAL COUNCIL OF GOVERNMENTS

Dr. MONTAGU. Thank you, Mr. Chairman, and welcome home.

Congressman Feeney, welcome to the great State of Colorado. I have no doubt that our Chairman has filled you in on the beauty of the wonderments of this great state, and I hope you get to enjoy your stay here. And I will attest that everything he says is true. This is a fabulous state, and I'm very proud to be part of the community here, the geospatial community, and present this testimony.

I am Simon Montagu, the Director of Customer Resource and Support Division of the Denver Regional Council of Governments, affectionately known as DRCOG. We are the federally designated metropolitan planning organization for the nine-county metro Denver region. We have 55 other governments ranging in size from communities such as Byers and Deer Trail on the eastern plains, all the way out to small mountain communities and the great cross section of communities that we find in a metro area like Denver.

Our specific focus is on various things like mobility services for the elderly community, the growing elderly community in Colorado. Water quality, long-range planning, and a whole bunch of other things that are best dealt with at a forum that addresses these intrajurisdictional issues at a common place.

We are obviously a great consumer of geospatial information, and much of that information derives from remote sensing technology. And so, therefore, we greatly appreciate the opportunity to present before this hearing, and give some sense of how we deploy these resources in our daily work flow, not only at DRCOG, but of course our 55-member governments that are part of the DRCOG membership.

In my written testimony, I've gone into some great detail about some of the specific examples. And really what I want to do today is just draw out one key point.

Our ability to do so is largely because of many decades of federal investment in the remote sensing industry, and both the indirect and direct follow-on benefits are federal involvement. So really what I'm asking for is a continuation of that federal investment in this program.

Some of the specific things that I did want to mention is, you know, first of all, LANDSAT and NOAA and the various other federal programs of the acquisition side are vital. LANDSAT data is being used at this moment in many of our mountain communities in DRCOG for wildfire management at the strategic planning site. I noticed photos of the Hayman fire which had a devastating effect on at least one of our counties, Douglas County, in terms of the water quality issues that came with that. So having imagery available is important to us.

NASA and its continuing involvement in areas like LIDAR is very important to us. LIDAR is growing in importance across the metro area in terms of its application. I mentioned in my testimony the fact that we are in the process of collecting LIDAR at this very moment for the downtown metro area in preparation for the Democratic National Convention coming up in August. That imagery,

that data will be used by the National Geospatial Intelligence Agency for their strategic and tactical planning in regard to the safety of all of those participants that will be at the convention.

We will also get access to that data going forward from that, and we should be able to use all of that to help public planning. We're very excited to be able to partner with the USGS and NGA to collect that data.

I think the third thing I want to mention is the leadership that many federal agencies have shown in terms of the distribution model of moving this data around. We're now reaching a stage of maturation for this industry. We have significant volume of data, and being able to get that data in the hands of the people that need it is critically important.

The USGS, the U.S. Department of Agriculture, and other federal agencies have taken a leadership role in terms of pushing this stuff out over the Internet and making it more readily available. Organizations like mine and the members that we represent need this data, but they can't necessarily store the vast amounts of data that are being produced. And so being able to access that and call on it when we need it is vitally important to us.

And so looking forward, then, what I'd like to ask is that the Committee generally think about the continuation of support for these federal programs that are not only doing the acquisition work, but also the distribution side of it. Specific programs to mention are the national map that the USGS is working on, and the National Agriculture Imagery Program, NAIP, which the USDA is working on. The NAIP Program allowed us to get full coverage of the State of Colorado, very recently, which is the first time that we've got that.

So just in closing, I'd like to ask specifically for support in terms of making data more readily accessible to everyone. And part of that is a policy solution in the sense of saying we want this data in the hands of folks that can use it. Part of it is also supporting those distribution mechanisms that I've talked about. The other one is to allow us a pathway to the Federal Government purchasing power to buy some of this imagery through federal programs and make it available. The Federal Government obviously has interest in the commercial side. We can't afford it, and we'd like to tap into the federal resources there.

Thank you.

Chairman UDALL. Thank you, Dr. Montagu.

[The prepared statement of Dr. Montagu follows:]

PREPARED STATEMENT OF A. SIMON MONTAGU

The Denver Regional Council of Governments (DRCOG) is a member-driven Council of Governments comprised of 55 county and municipal governments from across the greater Denver (Colorado) area. In its sixth decade of service, DRCOG is proud of its collaborative approach to protecting and enhancing the quality-of-life that make our region such an attractive place to live, work and play. Specific focus areas include mobility, service to older adults, environmental quality, planning for the future, public safety, and the provision of high-quality information for sound decision-making.

DRCOG has statutory responsibilities under both State and federal law to plan for the region's future, particularly its transportation infrastructure and overall growth and development. The signature product of this process, *Metro Vision,* embodies the collective vision of our member governments for the region and provides policies to guide where, when, and how much growth will occur across the region.

DRCOG's stewardship of this regional planning process has garnered many national awards and attracted international attention. We are rightly recognized as a world leader in collaborative, "bottom-up" regional planning.

A hallmark of our regional planning process is the timely, accurate and objective data that informs all of the visionary policies embedded in Metro Vision. Geospatial data—information about the physical, social and economic make up of our region—is vital to this process.

DRCOG is a major producer and consumer of geospatial data, large volumes of which derive from remote sensing (RS) technologies. DRCOG is therefore appreciative of the Committee's interest in the role of remote sensing data in regional planning, and grateful for the opportunity to present our views on both the opportunities and impediments to making the information derived from RS technologies more broadly available.

REMOTE SENSING DATA USE IN DENVER METRO REGION

Federal investment in research and development has and continues to be a significant driver in the growth and expansion of the Nation's geospatial information industry. DRCOG and its member governments leverage this investment in significant ways on a daily basis. We manage our urban environment, monitor the quality of our natural resources, plan for the future, and make informed choices about where to invest our scarce resources all with the help of data derived from remote sensing technologies.

Across the Denver metro area and the State of Colorado as a whole, local, regional and State agencies have come to rely on data derived from three general types of remote-sensing technologies:

- Aircraft-based aerial photography
- Multi-spectral data
- LIDAR and related technologies

AERIAL PHOTOGRAPHY

DRCOG and our member communities have relied on film-based aerial photography for many decades. High-quality orthophotography provides local communities with spatially accurate, distortion free base data layers critical to all of their planning, public safety and governmental management functions.

Since 2002, DRCOG has led a successful consortium of public and private participants to jointly acquire high-quality digital aerial photography for the DRCOG region, exploiting the collective buying power of 30 individual organizations. We repeated the effort in 2004 and 2006. and planes are currently in the air collecting 2008 imagery. This year, the project expanded well beyond the territorial limits of the DRCOG member region, allowing our neighbors in Weld and Grand Counties to also benefit from this joint purchasing power.

The benefits to our member governments and all the other public and private sector participants are very tangible. High-quality, high-resolution digital orthophotography of the type we're collecting typically cost $100–$150 per square mile. By contrast, the average cost for participants in the 2006 project was a mere $11 per square mile. The average cost for DRCOG members was less than $1 per square mile.

Colorado has a great tradition of this type of grass-roots, collaborative, goal-focused effort. DRCOG's public-private consortium model is mirrored in the Colorado Springs area, the emerging nine-county (15,200-square-mile) Sangre de Cristo Regional GIS Cooperative, and in the communities on the Western Slope.

Recently, the State of Colorado acquired statewide aerial photography under the auspices of the U.S. Department of Agriculture's National Agriculture Imagery Program (NAIP). This program allows State and local entities to leverage regular aerial photography acquisition efforts by the USDA to obtain statewide photography for a fraction of the total cost. Colorado was able to take advantage of this effort in 2005 resulting in the first complete coverage of the entire state all acquired at one time. The State would never have been able to afford this photography if not for the NAIP program. The data is now used widely by numerous federal, State and local entities, as well as the private sector and universities.

MULTI-SPECTRAL IMAGERY

The broad availability of space-based multi-spectral sensors (MSS) in the 1970s and 1980s extended and enhanced the functionality of traditional aerial photography, providing local, regional and State-level planners with a cost-effective way to analyze and map critical environmental processes across large geographic areas.

Multi-spectral imagery offers a number of data products from across the electromagnetic spectrum providing information that is imperceptible to the naked eye.

Many communities across the DRCOG region now utilize Color-Infrared (CIR) imagery, for example, to map impervious surfaces and monitor surface runoff and downstream water quality. CIR data also plays a key role in both the tactical and strategic aspects of wildfire management across the region. Douglas County, for example, recently acquired LANDSAT 5 data for mapping vegetation and modeling fuel loads in the Pike National Forest and other heavily vegetated parts of the county. Other cities and counties across the region have similar mapping programs.

Broader applications of MSS-derived data include mapping the massive Pine Beetle infestation in our mountain counties.

LIDAR AND RELATED TECHNOLOGIES

Light Detection and Ranging (LIDAR) and other related ranging technologies (Interferometric Synthetic Aperture Radar—IFSAR—for example) are becoming increasingly important to communities up and down the Front Range as acquisition costs decrease and data from these sensors become more widely available.

LIDAR provides an extremely cost-effective method for collecting detailed and highly accurate terrain information. This data then feeds into a range of sophisticated modeling processes that allow communities to more accurately map not only ground features within their communities, but also key anthropogenic structures such as buildings, bridges, dams, etc.

This information provides the foundation for the construction of three-dimensional models of cities that are now widely used in land use and transportation planning, emergency response tactical plans, and as aids in community involvement and visioning efforts.

Specific examples of LIDAR use in the Denver region include security planning around the upcoming Democratic National Convention. Working with several of DRCOG's member governments, the U.S. Geological Survey is currently acquiring LIDAR data on behalf of the National Geospatial–Intelligence Agency (NGA). The NGA will use LIDAR to identify line-of-sight and other tactical vantage points to plan their surveillance and response strategies to ensure the safety of all those attending the convention.

Several of DRCOG's larger member governments have acquired LIDAR in support of their planning and public works programs. The City and County of Broomfield, for example, is using LIDAR data in planning the development of a new reservoir. They also rely on the data for initial assessment of new roads and trail systems and for understanding the runoff and drainage implications of planned developments. LIDAR is also playing an important role in the modernization of flood insurance mapping across the state.

CHALLENGES AND IMPEDIMENTS

Although the use of data from remote-sensing technologies continues to grow across the DRCOG region, there are a number of structural and logistical impediments that both undermine our ability to use the existing data products, and limit our ability to integrate other RS data into current planning efforts.

Cost remains a significant challenge. The price tag for the 2008 DRCOG aerial photography project is over $1 million, in a climate of little to no revenue growth among the participating jurisdictions. This price reflects the combined purchasing power of 30 public and private sector partners working to acquire this data collaboratively. Market rates for digital orthophotography continue to increase despite the emergence of new capture and processing technologies (direct digital capture; automation, off-shore processing, etc.). Pricing of commercial satellite-based imagery remains similarly high, relative to the data budgets of most cities and counties.

High costs mean local, regional and State entities can acquire this data less frequently than they require. Our imagery program struggles to keep pace with the rapid growth of the nine-county region, but can only afford to acquire new data every two years. DRCOG estimates that our region adds on average about 100,000 new people, 65,000 new jobs and nearly 30 square miles of new development in any given two-year cycle. Understanding and managing this growth with out-of-date imagery is a significant problem for both the staffs and elected officials of DRCOG's member governments.

"Solving" this impediment is unrealistic expectation. The experience from Colorado is that communities working together, collaboratively, can bring their collective buying power to the commercial marketplace and reap significant savings over the cost of going it alone. This ground-up approach remains the most realistic solution to cost containment at this time, at least in the Colorado context. The only request

that I would put to the Committee is to continue to fund the various federal programs—most notably the National Map program led by the USGS and the National Agriculture Imagery Program led by the USDA—that allow federal agencies to collaborate with local partners to secure geospatial data all across the country.

A second impediment is the challenge associated with the sheer volume of remotely-sensed data that is now available. The estimated volume of data from DRCOG's 2008 aerial photography acquisition, for example, is over 10 terabytes. Few of our member governments have the internal capacity to store and maintain all of this data. The problem compounds with each new project, as part of the value of remote-sensed data lies in the ability to review multiple years of data at the same time (comparing changes over time).

Another dimension of this problem is the effort associated with distributing data. While Internet bandwidth continues to improve, online distribution of the large data sets associated with most remote sensing technologies remains impractical.

Fortunately, new models of data distribution are starting to emerge that facilitate the distributed storage and distribution of large geospatial data sets. Data throughput under these models is greatly reduced, pushing only the needed geographic window down to the end-user, rather than distributing the entire geographic data file.

Examples of this model exist in both the public and private sector. Several Colorado firms have established a national presence in this realm—DigitalGlobe, Inc. in Longmont, CO, Intrasearch Inc. in Englewood, CO, and Sanborn Map Company here in Colorado Springs. On the public sector side, federal agencies are playing a lead role. The USDA maintains its "Data Gateway," the USGS has a long history using the Internet for data distribution, and the "e-government" initiatives sponsored by the Federal Office of Management and Budget (OMB) lead to the establishment of the "Geospatial One-stop" portal.

Federal investment in research and development provided the initial impetus for the evolution of the Internet and federal agencies continue to lead by example in their innovative use of this infrastructure to distribute the tremendous wealth of geospatial information we now possess. I urge Members of the Committee to recognize the important leadership role of the Federal Government in this realm and continue to support those federal programs that are augmenting the data distribution services of the private sector.

My final comment in the area of impediments is of a technical nature. Like all technologies, remote sensing data applies better to some applications than others. Traditional multi-spectral technologies have tended to provide very broad-acre imagery that works well at a strategic planning level, but typically falls short when used for more tactical, response-type planning. This is particularly true in the area of wildfire management. Whereas the existing satellite imagery in the public domain provides useful input into fuel load modeling for understanding the threat of wildfires across our region, the resolution of the available imagery renders it unusable in emergency response situations. Commercially available data provides better resolution, but at a price that is often beyond the means of the typical fire protection districts that serve DRCOG's mountain communities.

OTHER DESIRED PRODUCTS AND SERVICES

On behalf of my peers across the DRCOG region and the State of Colorado, I wish to acknowledge the continued leadership of the Federal Government in the acquisition and dissemination of remote sensing data. I hope that the Committee now sees how local and regional governments leverage this federal investment every day in providing better, more efficient government to all our citizens.

DRCOG and its members have shown that local governments can realize significant cost-savings when communities band together to jointly acquire remote sensing data. This type of collaborative endeavor is not limited to the local or regional scale. With that in mind, I would like to suggest two other areas where greater federal engagement would significantly enhance the accessibility of remote sensing data to all levels of government.

First, recognizing the vast data libraries and the ongoing acquisition activities of the Federal Government, local and regional governments across the country have much to gain from greater access to these federal resources. Part of the solution is a policy decision to make the data more broadly available. The other part is continued support for the innovative data distribution strategies that we are seeing from key federal agencies like the USGS and USDA.

Second, following the collaborative models that we see across the State of Colorado, I would urge the Federal Government to allow local and regional governments to leverage the tremendous purchasing power of the Federal Government in the commercial remote sensing data marketplace. This industry continues to grow and is a vital part of our economy, particularly so in the Denver region. However, many

of the vital data products sold in the commercial marketplace are simply out of reach of the small public-sector entities that would benefit most from these products. Allowing these entities to work through federal agencies (and their purchasing programs) to acquire commercial imagery would realize significant benefits at the local level.

BIOGRAPHY FOR A. SIMON MONTAGU

Dr. Montagu is the Director of the Customer Resource and Support Division with the Denver Regional Council of Governments. This division is one of five core divisions within DRCOG and is responsible for the production and dissemination of the geospatial, socioeconomic and travel modeling information produced by DRCOG. The division also oversees the production of the "Growth and Development" part of *Metro Vision,* the long-range strategic plan for the Denver metropolitan area.

In his seven years with DRCOG, Dr. Montagu has served as Geographic Information Systems Coordinator and Regional Information and Research Manager. Prior to DRCOG, Simon was an Assistant Professor in the Department of Geography at Miami University in Oxford, OH, where he taught classes in GIS and Urban and Regional Planning.

Dr. Montagu holds a Ph.D. in Regional Planning from the University of Illinois at Urbana–Champaign and undergraduate degrees in environmental science and natural resource management from Griffith University in Australia. He has over 20 years experience in the geospatial information technologies realm and has worked in a number of capacities across the United States, Australia, and the South Pacific.

Chairman UDALL. Mr. Navarro.

STATEMENT OF MR. MANUEL NAVARRO, FIRE CHIEF, CITY OF COLORADO SPRINGS FIRE DEPARTMENT

Mr. NAVARRO. Thank you. My name is Manuel Navarro; I am the Fire Chief of the Colorado Springs Fire Department in Colorado Springs, Colorado. I think it's important to note that we have submitted a brief and we have many details in that and I'll just sum those for you.

I think it's important to note that I'm a practitioner. I've been in the field for 41 years. I know you're saying, how old is this guy? The reality is that I'd like to talk to you a bit about both mitigation and response from a fire chief's standpoint and how we can leverage some of the technology in our organization to help us with those issues.

On the mitigation side of it, I call your attention to some of the things that have happened in California. And by the way, I spent 28 years in the fire service in California. It wasn't open in 1991 when a fire devastated several residential properties and killed 25 individuals. The map we used that day was hand drawn, and that was in 1991. As a matter of fact, that map—I drew some of the maps in that. That's how bad the technology was on the fire service side of it. We've been able to use that technology here, at least that geospatial technology to get some good maps now.

Because one of the concerns we have, obviously, is seven days a week, 24 hours a day, when a call for service comes in, we need to find that location, and specifically that address, and we're leveraging that now with other GIS data to be able to weigh the situation so that we have situational awareness when we get on the site.

Oftentimes, we're sent to facilities or occupancies where we have no idea what's in that unless we've experienced inspection beforehand. And given the size of our community, we simply can't do

that. So that base layer and all the technology that follows that is extremely, extremely important on the response side.

I think you've got a picture of the Hayman fire. I'm not sure exactly when that was taken. Some of my planning staff was able to facilitate some of the planning efforts there. But I will tell you, on the ground, in a wildland fire, most fire officers really have to lay a map out in front of them and guess at what's happening. They don't have realtime analysis. We simply weren't able to leverage that with programs like Global Hawk and Predator. And I can tell you how exciting it is from the response side of that to be able to have situational awareness and realtime information relative to what's going on with the fire.

This is real personal stuff for us. A few years ago there was a fatality in a San Diego fire. My nephew, who is a firefighter in California, was at the end of that cul-de-sac and was told to back out and stop, back out. And when he came back out, he saw the fatality there because the fire had turned on him and moved. When you're in that position, it's so hard to tell.

On the mitigation side of that, we've done some very interesting things. We're able to use risk analysis and portray that on our web site. And our folks here in Colorado Springs are able to go to that web site, take a look at that, and be partners with us.

Chairman UDALL. Mr. Navarro, can you pull the mic a little bit closer? Some of the audience—no, you wouldn't know. Some of the audience—all the witnesses need to have it a little closer so the audience can hear.

Mr. NAVARRO. We'll try this. Is that better?

On the mitigation side of it, we've been able to leverage that technology to be able to get partners in our community. And most recently, the greatest example of that is FEMA has awarded us with a million dollar grant here in Colorado Springs. The match for that has been neighborhood associations and local government to be able to clean up some of the fuel. What we hope to prove is that on the front end of these disastrous fires, we can have more info.

Just in concluding, I must tell you that local government is really strapped to be able to leverage technology. When I talk to my staff, they simply say we don't have enough staff. We don't have enough resources, and the projects that we have in front of us, just to meet the mission locally, is overwhelming us. We were able to leverage an AVL system simply because we got really lucky. Public works got a grant from the Federal Government to be able to do that, and that helped us move that AVL system on our fire trucks. Otherwise we wouldn't have had that at all.

In conclusion, thank you very much. Thank you for your interest. And the fire service is more than willing and able to be able to sit down with you and talk about some of the specifics relative to this type of technology.

Chairman UDALL. Thank you, Mr. Navarro.

[The prepared statement of Mr. Navarro follows:]

PREPARED STATEMENT OF MANUEL NAVARRO

Introduction

Thank you for the opportunity to appear before the Committee on Science and Technology and discuss with you some of the experiences that the City of Colorado Springs and the Colorado Springs Fire Department have encountered in applying

remote sensing and geospatial information systems to improve our emergency response and preparedness.

My name is Manuel Navarro; I am the Fire Chief of the Colorado Springs Fire Department. As a 41-year veteran of the fire service, I am honored to present to you today. Across my career and as the Chief of the Colorado Springs Fire Department, I have had the privilege to lead firefighters and emergency response personnel in dangerous and life threatening situations with a constant focus on our responsibility to protect lives and property from fire, medical, and disaster events. Finding new ways to plan for, prepare, and respond to emergency situations is something that I have charged my department with from the day I arrived in Colorado Springs. I think we have made some impressive advances in improving citizen preparedness, community resiliency, emergency response planning and operational situational awareness that I would like to share with the Committee. At the same time, we have encountered some hurdles and lessons along the way that I would also like to share.

In my presentation to the Committee, I will discuss the importance of gaining and maintaining situational awareness of the environment necessary for effective and safe firefighting. In the City of Colorado Springs, we have realized that remote sensing technology and geospatial information are key tools in improving our ability to shape the environment that we operate in. We now rely on these tools to help us prepare and plan for potential hazard and risk events, communicate with our citizens and adjacent emergency response agencies, and make the right decisions while deploying in initial attack or during sustained operations during a large scale wildland fire.

Before I offer testimony regarding the aforementioned issues, I think it is important that we establish a common understanding of the complexities involved with managing fire service response to emergencies, 24 hours each day, seven days each week. As we deliver emergency services, there can be no excuses regarding our response—lives and property are at stake; it must be timely, we must get to the proper address or location and we must be proficient in rendering the services we provide. With that said, we have grown to understand the value that planning has for our organization. We must respond, we will respond, we will make tough decisions—but there is no need for us to have to make those kinds of decisions without the benefit of a very strong planning process. One bit of institutional humor for us is that the fire service represents 150 years unimpeded by progress. Well, fortunately, we have undergone a sea-change in our thinking where we have come to understand that planning and mitigation work literally "shapes the battlefield" in which we operate tactically. For Colorado Springs, the operational response mission must be accomplished, in our case, from a network of twenty fire station locations housing fire companies that are staffed by three different working shifts. But it doesn't require that we make our hard decisions without the benefit of thorough analysis and thoughtful response. Management of the training, logistics and standard operating procedures of fire companies to support this mission is challenging for any fire chief.

Emergency Response

When we receive a 911 call for emergency services, the appropriate emergency unit must be notified and that crew must correctly navigate heavy apparatus through heavy traffic conditions and difficult weather conditions at any time, day or night, to the address or location. Accurate maps, occupancy of buildings and location of response vehicles is essential in completing our mission and to ensure the safety of the responding firefighters.

The Colorado Springs Fire Department has employed geospatial technology for 25 years to create the most accurate map for the city and adjacent areas. As our city has experienced significant growth and development over the last several decades, the ability to accurately map new and changing streets have proven to be critical in dispatching emergency apparatus rapidly, effectively, and efficiently. Using the accurate base maps, we employ additional GIS technologies to layer critical information that can be utilized to provide additional information associated with that location or address to responding fire companies.

I cannot adequately express to this committee how important it is to provide responding fire officers with critical information regarding a specific building or hazard. The information allows fire officers to efficiently make critical decisions on the way to and at the scene of an emergency. Those decisions based on accurate information, coupled with the education and experience of the fire officer, lead to safely controlling emergencies while at the same time limiting property damage, saving lives and providing for the safety of responding emergency personnel.

Lacking local resources to develop this additional functionality was a challenge for us here in Colorado Springs. The city's Public Works Department recently received

a federal transportation grant to develop Automatic Vehicle Location System (AVL) technology. The fire department had an opportunity to collaborate with our own City Traffic and Public Works Divisions in the development of the AVL system that provides the following functionality:

- Locates every emergency that is identified by the Emergency Dispatch Center and transmits it to the traffic signal system computer.
- Provides every dispatched emergency unit with a map display showing a route to the location.
- Preemption that signals the traffic lights along that route to turn green as the emergency unit approaches the intersection.
- An on-board touch-screen computer developed by the department's I.T. staff, mounted in each emergency vehicle to archive and display additional layers of information.
- Situational awareness delivered through the on-board computer which displays available data for the scene.
- Wireless, hands-free data updates (each fire station has been linked so that data can be updated to the on-board computer).

The base map originally developed with geospatial technology has been leveraged to work with the AVL system. It now provides routing capability for emergency vehicles to the location of an emergency and provides safe emergency response by controlling intersections. The base map is also used to identify individual addresses which in turn is used to access the base for layers of GIS information essential to safe and effective emergency operations. In the near future, fire companies will be able to develop pre-plans for individual occupancies that will be added as additional layers of information available in the apparatus to responding fire officers.

We are in the final process of reconciling our map centerline data in our computer aided dispatch (CAD) system to provide automatic vehicle location dispatch and move away form the current CAD tabular dispatch system. Once we have moved to that technology we will be able to improve response times without adding additional responding units to the department by always dispatching the nearest appropriate emergency unit.

Wildfire Risk

The department has also employed remote sensing in the form of hyperspectral imagery to study the city's wildland-urban interface areas and watersheds. This remote sensing technology provides us with detailed mapping of fuels, construction features, vegetation types, densities and locations that previously could only be categorized and mapped by laboriously walking and inspecting each area. Hyperspectral remote sensing data is one of the most promising data collection sources for planning and mitigation efforts related to wildland fire, community risk, and environmental hazards. As a remote sensing data source, hyperspectal information allows communities to collect high quality data and extract multiple information elements from a single flight. We have collected and analyzed hyperspectral data to detect and map specific features such as the type and status of wildland fire fuels, the densities and location of high risk vegetation species, and the conditions and physical traits of at-risk structures and access roads. All of these traits are of special concern during active fire fighting operations and typically are unavailable prior to incident operations. Highly accurate and data rich remote sensing sources like hyperspectral systems provide decision-makers with true situational understanding and awareness of the terrain, access, fuel and vegetation layers and building arrangements and locations. Within the Colorado Springs Fire Department, this data is used across almost all of the department's operations ranging from mitigation to response.

CSFD staff is currently developing a wildland urban interface (WUI) plan for the drainage areas and neighborhoods in the city's wildland urban interface. We will integrate the layer of fuels data provided by the hyperspectral imagery with current information on fire behavior to provide responding command officers with planning and operational situational awareness. We are also developing a map layer with specific information to assist command officers in positioning staged apparatus, evacuation zones and safe refugee areas, as well as displaying other potential fire control and resident safety issues.

Community Education

The department's Community Services staff has also employed this technology to inform and motivate community members to "FireWise"[1] their property. We have created an interactive web site that maps each individual property and their risk rating with regard to wildfire risk. Individual property owners can then access the information utilized to develop the risk rating of that property and, more importantly, how that rating can be improved by employing FireWise risk-reduction treatments to the property.

We have employed technology to leverage the efforts of staff in educating the thousands of households in the Colorado Springs wildland-urban interface areas. Here in Colorado Springs we have approximately 40,000 residential properties in these interface areas. Effective use of technology has greatly enhanced our efforts in community education with regards to wildfire mitigation. I think this is an important distinction to make. We have transitioned the use of remotely sensed information from purely reactive and tactical to a forward thinking, mitigation and planning effort. I think it is understood by this group that remote sensing technologies are tried and true in the operations arena—particularly the larger the incident is. However, we have come to see much more value that these rich data sets can provide to us long before the incident begins. Our focus has increasingly transitioned toward using the information provided by remote sensing as a real asset in our planning and mitigation work. Our use of hyperspectral data is just one example of how a local jurisdiction provided the specific information with which we could employ our risk analysis and thus educate individual property owners.

The use of these technologies has provided us with an opportunity to change our approach to creating a safer community. By employing innovative uses of remote sensing and geospatial technologies, citizens in our city are educated and motivated to treat their own property and not rely on local government to provide that service. We have developed a culture in our city that encourages citizens to partner with local government to provide public safety. By creating our web site we have greatly improved our efforts in getting individual property owners and neighborhood associations to partner with us in mitigating the fuel in these interface areas. Perhaps this seems subtle, but it is an important note: these efforts have created an environment in which our citizens actively participate in their own outcome, effectively sharing the responsibility—and that, after all, is the very definition of community.

Grant Proposals

The layers are also used to develop grant proposals utilized to secure funding which support community wide fuel mitigation projects. In a recent example, the City of Colorado Springs was awarded a one million dollar mitigation grant by FEMA. That FEMA grant was the only one of its kind in the Nation. I firmly believe we would not have been successful in winning that grant had it not been for the robust data we were able to employ in the planning and justification for the grant. It was successful in large measure due to the capability we developed with our risk analysis of wildland fire issues using hyperspectral data. We were able to leverage our investment in remote sensing to make a strong case to FEMA that we knew both the nature of our problem and how to fix it.

Community Risk

Additionally, we have also embarked on developing a very sophisticated community risk assessment model. The model uses geospatial data[2] which are evaluated by all community stakeholders, to assess and categorize risk. It is a mixed-methods approach that couples the input from subject matter experts and the community inputs (qualitative) with mathematical models (quantitative) that describe not just where events have happened, but the very causes of those events.

The results of these assessments are clearly displayed on a map with shadings indicating the degree of risk severity. The visual display quickly communicates the location and extent of community risk so that citizens and policy-makers can openly and with confidence discuss mitigation strategies. This is an important success for us to highlight. This illustrates the success we have in communicating with our pub-

[1] "The national Firewise Communities program is a multi-agency effort designed to reach beyond the fire service by involving homeowners, community leaders, planners, developers, and others in the effort to protect people, property, and natural resources from the risk of wildland fire—before a fire starts. The Firewise Communities approach emphasizes community responsibility for planning in the design of a safe community as well as effective emergency response, and individual responsibility for safe home construction and design, landscaping, and maintenance." (*www.firewise.org*)

[2] Includes geospatial data describing the city's natural, social, and built environments.

lic due to our use of GIS and remote sensing technologies. If a picture is worth a thousand words, how much is a dynamic living picture of risk and exposure worth to a community that can access it 24 hours a day, seven days a week. We prepare to respond 24x7, so why wouldn't we mitigate and communicate the same way.

One of the innovative approaches that we are taking is that the results of the qualitative criterion can be displayed next to quantitative criterion and where there is convergence; policy-makers can have assurance that they are developing a good decision that represents realistic informed consent in the affected communities. Where the data does not converge, policy-makers can call out subject matter experts and citizens to discuss the difference in opinions.

Funding

Locally, we have been challenged in developing the technology needed to provide operational decision-makers and policy-makers with accurate, current and comprehensive data. Grant funding for the AVL system came to us by happenstance through our Traffic Department. They had a 900 MHz radio system and wanted to develop the vehicle location technology. We were able to place staff on the project and not only developed and tested their applications but developed the application for our emergency apparatus. We were very fortunate to be able to take advantage of that transportation grant (Congestion, Mitigation and Air Quality—CMAQ) as such funding is not available locally, through the state or through National Fire Administration grants.

The funding necessary for the geospatial and remote sensing over flights was carved out of current operational budgets and partnering with other interested city departments. We were very limited in the amount of resources we could employ to gather this data. Again, this technology and data is vital to our public safety work but we found very little support in the form of grant dollars to complete this work.

As my staff discusses the issues regarding development and use of technology in the fire service, they portray the problem in clear and concise terms; there is no staff dedicated to these projects, there is little additional time to allocate to these projects, and there is no funding to have the work completed by others and yet we have this essential mission to complete.

Education

I would add that employing current technology is also a significant educational challenge for the fire service. Few, if any, fire service officers that are adept and capable in emergency operations work have formal education or experience with modern technology. We have been fortunate to have an accomplished information technology staff in-house that supports our public safety mission. The collaboration between experienced fire officers and a very sophisticated information technology staff has allowed us to take advantage of finite resources and create innovative approaches to community safety employing new technology.

IT Staff

When I took command of this department some 14 years ago, I had a departmental information technology division. We had fire operations staff working side by side with a very talented group of IT and GIS staff. The combination of those two groups of very talented employees allowed us to investigate, research, and create opportunities to employ technology in the work we do. The results are that this department is on the leading edge of utilizing technology to improve the effectiveness and efficiency of the department.

Training

Operationally, fire officers rely on training, education and experience as a foundation in making decisions regarding management of a variety of emergency situations. Then at the scene of an emergency, officers and firefighters must apply that training and situational understanding to the facts and observations made at the incident to develop situational awareness.

Technology can provide a large quantity of data through GIS layers supported by remotely sensed information and associated with a specific site and a specific type of incident. That information will not be easily processed nor understood unless we begin to train fire officers on how to recognize that information and use it in a situational awareness process. The fire service currently lacks that training and I know of no support for that training.

2008 California Fire Siege Example (move to emergency response and operations section)

The information available with the use of technology must also be employed in the operational planning process prior to an emergency and as the emergency involves. We saw a graphic demonstration of this application in the recent California wildfires. At that fire, overhead assets in the form of satellite platforms, unmanned aerial vehicles (UAVs) from NASA and DOD, National Guard, civil and commercial fixed wing and space-borne assets were able to bring into the planning process of the command post real-time data including full-motion video. Technology available to the military that provides situational awareness was deployed in California and from my opinion has the potential to greatly improve our ability to manage and control these large wildland fires—particularly if these assets are directed by local and State authorities with a mechanism to quickly capture, store, and disseminate the information. It doesn't really matter if we have this powerful remote sensing capability and we don't put the information in the hands of the actual boots on the ground when they need it. We should thoughtfully consider how we could institutionalize this capability vice scrambling when large events inevitably overtake us.

Personal Experience

I can tell you from experience that management of large wildfires is a most difficult task and having current and comprehensive data, maps of predicted fire behavior, and fire location and live video feeds are of tremendous assistance in managing the fire, saving citizens at risk, and controlling the position of fire apparatus and firefighters. In 1991, I was a command officer with the City of Oakland when in one afternoon we lost over 3,300 residential properties and the lives of twenty five people.

We did not have a map of the fire's perimeter or know the extent of damage until late that night. The perimeter of the fire was drawn by hand over an existing city map by a fire officer hanging out of a helicopter as it flew the area.

There are significant issues with bringing this technology to the fire service. As stated, there is a lack of resources and funding to acquire the technology and to gather the data. There is also the issue of training fire officers to understand and employ that data in their decision-making. We also have an issue with standards.

Standards—move above Personnel Experience

In association with the International Association of Fire Chiefs, there has just recently been established a Technology Advisory Council to standardize data collection, storage, and exchange. The National Fire Protection Association has also begun to appoint a technical committee on Fire and Emergency Service Geographic Information Systems that will explore geospatial data needs and current applications to develop common fire service standards and protocols for exchanging geospatial data between GIS user agencies and organizations during emergencies. Perhaps for the first time, essential data elements gathered by local responders can be utilized by incoming mutual partners whether they are local, State, or federal. The development of standards is an essential step in developing GIS information that can be utilized by the fire service.

We recently hosted a meeting of many individuals involved with these projects so that they could share their individual efforts in order to develop a National Fire Service Data Model for gathering this data. That effort should receive continued support as we explore the development of this standard and look towards implementation at the local level.

Personal Comments

I perceive in the implementation of remote sensing technology that there are many issues regarding the use in the fire service for response and mitigation activities. I do not profess to have sufficient expertise to comment on the technical aspects of development of such technology. I can tell that you what we have done here in Colorado Springs has greatly leveraged our ability to provide the best in public safety with regards to fire control and suppression and community education.

I will offer that the leadership in the fire service and the emerging leadership must be trained so that they can fully employ the available emerging technology. Most fire officers have learned their trade through training, classroom and didactic, and with application of that training in practical experience. The introduction of remote sensing and GIS into the work we do must be accompanied by training and practice. That training will come at some cost. As with any training program, we must provide the training staff, develop the curriculum, and pay for the wages of

the attendees. The training then has its associated cost, all of which must be provided with finite resources currently available to local government.

I have been asked by the Committee to discuss how we have utilized remote sensing data and to also comment on barriers. Briefly, I have discussed with the Committee some of our work regarding how we have utilized this technology. With regards to barriers I would comment that there are several:

- Funding for such work is lacking at the local level. Local government has finite resources that are wholly dedicated to providing services and at the federal level, there are few available resources for this emerging technology in the fire service.
- As we develop this technology and move to applications for response and mitigation, a national standard should be supported so that local, State and federal response resources can all utilize the data.
- There is a need to develop national policies, standards, and functional models to enable data sharing and coordinated data exchange starting with local agencies for decision support and situational status to incident commanders during escalating events of national significance.
- Implementation of this technology must be accompanied with training of the current and emerging fire service leadership. Perhaps it is possible to fund the U.S. Fire Administration to develop a program through the U.S. Fire Academy that provides support curricula with appropriate GIS and RS training. Additionally, some sort of train-the-trainer program for GIS specialists in the fire service would create capacity nationally.
- The federal grant funding systems could recognize the value of the implementation of these technologies as a key piece in planning and risk-reduction efforts. It has been difficult to use grant mechanisms for these purposes despite the huge successes we have had in our communities when we have used remote sensing and GIS together.
- The geospatial intelligence strategy to support national security and preparedness must start at the local level. This cannot happen until locals have access to effective GIS and remote sensing products that support their daily operational requirements. Effective widespread implementation of fire service technology will require appropriate data, tools, funding, and education delivered to local responder agencies. These components need to be defined by appropriate input from the fire service, for the fire service. This can be accomplished by working through existing national fire service organizations and leadership structures, most of whom have identified GIS and remote sensing as an important technology for supporting their mission.

Conclusion

In closing, the Committee was also interested in comments regarding what would be most valuable to the fire service in expanding the use of remote sensing data for the future. We certainly support the use of geospatial information systems and the remote sensing data that feeds data to it. Fire officers will find that information extremely helpful in managing and controlling emergencies. The technology to support those activities in our estimation should be further researched and funding needs to be provided to make that technology available at the local level.

We have been very successful in employing data from remote sensing platforms to enhance our community education programs, to assist in the planning efforts with regards to fuel mitigation, and to provide an easily understood display of community risk to citizens and policy-makers. We were able to employ remote sensing to gather data that would take prohibitive personnel and time commitment to gather. We would support further research in the use of this technology to gather additional information such as roof types and other data essential to full development of community risk attributes.

Colorado Springs has shifted from binders on bookshelves to a community-based, geospatially enabled risk-assessment methodology. We have strived to understand the nature and characteristics of risk and then systematically work on risk reduction activities. We are developing mitigation strategies in addition to our response applications. We believe that responding to emergencies without really seeking to know what the underlying causes of the problems are is only part of creating a safer community. We support technology that provides us with the data required to understand and analyze the community risk.

We have been very fortunate in Colorado Springs with developing and utilizing remote sensing technology. We have utilized local staff and collaborated with some extremely talented private sector contractors.

We would strongly encourage the Federal Government to support these types of activities at the local level in order to improve the fire service's response to public safety as well as provide situational awareness for incoming local, State, and federal assets during major emergencies.

Again, thanks for having me here today, I would be happy to take any questions you might have.

BIOGRAPHY FOR MANUEL NAVARRO

Manuel Navarro was born in Oakland, California. He was a life-long resident of the San Francisco East Bay area until January of 1994 when he was appointed Fire Chief for the City of Colorado Springs. Chief Navarro's 41-year career began in the San Francisco Bay area in 1966 and he has served as firefighter, Lieutenant, Captain, Battalion Chief and Assistant Chief prior to being appointed Chief of the Colorado Springs Fire Department.

Chief Navarro holds an Associate of Arts Degree in Fire Science and a Bachelor of Arts Degree in Public Administration with a minor in business. In 1995, he attended the Kennedy School of Government, Harvard University, being awarded one of four National Fire Protection Association fellowships given that year. He holds a State of California Master Fire Instructor Certification and is certified to teach a number of specialized fire science topics.

Chief Navarro is an experienced and knowledgeable fire command officer and participated as a command officer in three nationally declared disasters (1989 Loma Prieta Earthquake, 1991 Oakland Hills Fire and 1992 Hurricane Iniki, Kauai). The Chief is considered an expert in many technical areas—most notably in the field of Urban Search and Rescue. He was responsible for the management of the Oakland sponsored Federal Emergency Management Agency (FEMA) National Urban Search and Rescue Team and served as a member of the FEMA Urban Search and Rescue Management and Control Committee.

Chairman UDALL. Mr. Sapio, the floor is yours.

STATEMENT OF MR. FRANK J. SAPIO, DIRECTOR, FOREST HEALTH TECHNOLOGY ENTERPRISE TEAM (FHTET), U.S. DEPARTMENT OF AGRICULTURE

Mr. SAPIO. Mr. Chairman and Members of the Subcommittee, thank you for this opportunity to testify before you today on remote sensing data, its applications and its benefits.

The Forest Service uses remote sensing technology "to foster the development and use of technologies to protect and improve the health of America's forests." Remote sensing technologies have serviced resource management well in the past, and will be an increasing part of land management in the future. When used effectively, they provide a means of data collection that is accurate, timely, and cost effective.

In our technology development, we try to select the appropriate remote sensing methodology. The spatial, temporal and cost capabilities of each sensor must be carefully evaluated for each project. If an appropriate match can be made, the Forest Service will try to use that technology to aid it in the natural resource assessment efforts. This assessment must be tactical, and they use imagery from a broad scale to a fine scale. Some systems are government-owned. Some systems are commercial systems.

Remote sensing is used at three principal scales, a broad scale to a strategic regional and national assessments, and mid-scale to assess landscapes, and a fine scale to aid in the mapping of forest stands and areas of damage.

On a broad scale, our current data-collection methodologies from national insect and disease assessments rely heavily upon aerial sketchmapping surveys. These surveys are accomplished by aerial

observers flying in light aircraft who sketch observations on paper or on pen-based portable computers. Though somewhat limited in spatial accuracy, this low-tech approach is appropriate technology and is particularly well-suited for trend analysis because we can cover almost the entire country annually. This method was used in developing a 2007 map of infestation in Colorado, and has been our method of choice for some time.

Imagery collected at a broad scale also includes satellite images from NASA, and NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) which provides 250-, 500-meter and one kilometer spatial detail. MODIS is used to detect and monitor wildland fires, assist incident coordination, and to portray the fire situation to the public. MODIS is utilized with other geospatial layers and forestry inventory information to produce large-area forest cover-type maps and biomass maps.

Mid-scale imagery such as Landsat which is 30-meter resolution and is used with geospatial data and forest inventory information to produce individual tree species maps to be used as insect and disease host layers for the production of the National Insect and Disease Risk Map, a five-year strategic assessment produced by Forest Health Protection. My office is currently preparing for the 2010 National Insect and Disease Risk Map. We are actively pressing for more modern methodology to be used in Colorado.

Landsat also provides the predominant mid-scale imagery driving the LANDFIRE project. LANDFIRE is a five-year, multi-partner project that produces consistent and comprehensive maps and data describing wildland fuels and fire regimes across the United States. It is a shared project of the U.S. Forest Service and the Department of Interior. LANDFIRE data products are created at a 30-meter resolution data set. LANDFIRE information is produced at scales that may be useful for prioritizing and planning hazardous fuel reduction and ecosystem restoration projects.

At a fine scale, aerial imagery is utilized to aid in the mapping of forest stands and damaged areas at a fine scale and is used routinely for forest inventory and local resource assessments. The U.S. Forest Service participates in the USDA National Agricultural Imagery Program, which collects one-meter digital imagery on a five-year recurring basis. This imagery is used in mapping various resource conditions.

Project level planning requires finer resolution imagery. The Forest Service and other cooperating field units often utilize digital high-resolution satellite imagery to assess local forest issues, such as damaged and dead trees in the landscape. To be able to discern trees that are just beginning to exhibit the effects of stress, field practitioners prefer the six-inch and one-foot spatial-resolution range. Airborne imagery, usually photography, as opposed to the satellite imagery, is currently the imagery of choice for most field foresters. In fact, my group is currently processing a large batch of photography for Colorado.

We also use remote sensing technologies for complex issues tied to land use. For example, the growing metropolitan fringe is extending farther into rural areas with attractive recreational and aesthetic amenities, and areas where structures and other human development meet or intermingle with undeveloped land. This

land-use change has significant implications for wildfire and pest management.

We use a myriad of geospatial technologies to conduct analysis of WUI at different spatial and temporal scales.

Mr. Chairman, this concludes my prepared statement. I would be happy to answer any questions you or other Members of the Subcommittee have. Thank you.

[The prepared statement of Mr. Sapio follows:]

PREPARED STATEMENT OF FRANK J. SAPIO

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to testify today on remote sensing data applications and its benefits for the U.S. Forest Service.

Introduction

As Director of the Forest Health Technology Enterprise Team (FHTET), I am charged with managing the group's mission "To foster the development and use of technologies to protect and improve the health of America's forests." Remote sensing is one of the geospatial technologies we use to fulfill that mission.

FHTET is a Forest Service unit within State and Private Forestry. The team is comprised of two offices, one in Morgantown, West Virginia, and the other in Fort Collins, Colorado. In Morgantown, members of the team work on the biological control of invasive pests, pesticide application technologies, and the study of non-target impacts of pesticides. In Fort Collins, team members work on a variety of information gathering methods, including geographic information systems (GIS), spatial analysis, remote sensing and image analysis, pest and pathogen modeling, invasive species modeling, and quantitative analysis of the impacts of forest pests.

I have worked in forest pest management and forest health for over 26 years. My career began as a research associate in a university setting where I developed forest pest management methods. I then moved to State government where I worked on forest inventory, forest health monitoring, and forest pest management for most of my career. For almost five years, I have been the technology-development lead within Forest Health Protection, U.S. Forest Service, as the Director of FHTET.

I will organize this testimony along the lines of the questions posed by Subcommittee Chairman Mark Udall's office in a letter to me dated March 26, 2008.

Questions and Answers

How is the Forest Service using data collected by remote sensing technologies to identify areas of high risk for forest fires and other factors, including insect infestations, disease, drought, and the proximity of forests to development that affect the health of forests in Colorado and elsewhere?

Remote sensing is used at three principal scales within the agency by both wildland fire and the forest health protection programs of the Forest Service.

Broad Scale

Our current data-collection methodologies for national insect and disease assessments rely heavily upon aerial sketch-mapping surveys. These surveys are accomplished by aerial observers flying in light aircraft who sketch observations on paper or on pen-based portable computers. Though somewhat limited in spatial accuracy, this very low-cost survey provides a quick and timely assessment for many insect and disease events. This "low tech" approach of information acquisition is truly an "appropriate technology" for strategic regional and national assessments and is particularly well-suited for trend analysis. Digital sketch mapping uses a moving map display on which the observer marks the screen instead of marking on paper maps. This saves time in processing finished maps and improves location accuracy. We continually strive to improve the collection of these data and have implemented digital aerial sketch mapping systems to improve the quality and timeliness of these data sets.

Imagery collected at the broad scale also includes satellite images from the National Aeronautic and Space Administration (NASA) and National Oceanographic and Atmospheric Administration (NOAA) Geostationary Operational Environmental Satellites (GOES) and Polar-orbiting Operational Environmental Satellites (POES) to support domestic forestry and fire programs.

The Moderate Resolution Imaging Spectroradiometer (MODIS) provides 250m-, 500m- and 1km-resolution spatial detail. MODIS is used to detect and monitor wildland fires, assist incident coordination, and to portray the fire situation to the public. MODIS is utilized with other geospatial layers and forest inventory information to produce large-area forest cover-type and biomass maps. These maps are used in national assessments and are designed for strategic assessments. For example, a cover map for all of America's private and public forests was recently completed by combining multi-resolution imagery from MODIS and Landsat with ground data from the Forest Service's Forest Inventory and Analysis (FIA) program. Much of this work is a continuation of interagency cooperative research and development activities spawned by the Multi-Resource Land Cover (MRLC) Consortium led by the Department of the Interior's Geological Survey. We are also applying these broad-scale synoptic mapping technologies to develop early warning systems and to produce very large area damage maps. We hope to be able to post forest disturbance maps on the web in near-real-time to guide our aerial surveys. The goal here is to augment and optimize aerial sketch mapping surveys (by providing near real time forest disturbance information to our aerial surveyors) that provide us with the majority of our national damage trend information.

Mid Scale

Mid-scale imagery such as Landsat, which is 30 meter resolution and is used with geospatial data and forest inventory information to produce individual tree species maps depicting the tree layers that host insect and diseases. These maps will be used in the production of national risk maps. Mid-scale imagery is a significant activity in the FHTET Fort Collins office as we are preparing the development of national host models to be used in the next development of the National Insect and Disease Risk Map, a five-year strategic assessment produced by Forest Health Protection. The 19-state, mid-scale hazard assessment for the Southern Pine Beetle Prevention Program is a good example of how this technology is currently being used.

Landsat also provides the predominant mid-scale imagery driving the LANDFIRE project. LANDFIRE is a five-year, multi-partner project that produces consistent and comprehensive maps and data describing wildland fuels and fire regimes across the United States. It is a shared project of the U.S. Forest Service and the Department of the Interior. The data products from LANDFIRE include layers for vegetation composition and structure, surface and canopy fuel characteristics, and historical fire regimes. LANDFIRE national methodologies are science-based and include extensive field-referenced data. LANDFIRE data products are designed to facilitate national and regional level strategic planning and reporting of wildland fire management activities.

LANDFIRE data products are created at a 30-meter resolution data set. LANDFIRE information is produced at scales that may be useful for prioritizing and planning hazardous fuel reduction and ecosystem restoration projects. LANDFIRE meets agency and partner needs for data to support large landscape, fire management planning and prioritization.

Satellite imagery is likewise used for the burned area emergency response (BAER) program for developing a burn intensity index to guide on-the-ground rehabilitation efforts. Landsat, ASTER (Advanced Space-borne Thermal Emission and Reflection Radiometer) and an increasing amount of commercial satellite imagery (such as Advanced Wide-Field sensor (AWiFS)) are being used to provide BAER teams with rapid assessment burn severity map products.

Landsat has also been used repeatedly within the agency in various change-detection analyses. One such notable effort is the U.S. Forest Service Land Cover Mapping and Monitoring Program (LCMMP) in California, which addresses statewide vegetation mapping and long-term monitoring using remotely sensed data. Remotely sensed data and GIS are used to generate maps that describe the extent and condition of various land cover types and the magnitude and cause (e.g., urbanization, natural succession, wildfire, and timber harvest) of land cover changes. The LCMMP provides a single, consistent source of current land cover data from which the U.S. Forest Service and California Department of Forestry (as well as other interested Federal, State, and local governments and private citizens) can make informed resource management decisions. The LCMMP is a collaborative approach to land cover mapping and monitoring that includes coordinated acquisition of resource photography, satellite imagery, and geo-processing on a five-year cycle. Regionally, monitoring can identify critical causes of change or provide an early warning system for habitats being degraded. Locally, monitoring can assess county land use policies, identify areas of insects or disease problems, or assess the extent of timber harvest in a watershed.

Fine Scale

Aerial imagery is utilized to aid in the mapping of forest stands and damaged areas at a fine scale and is used routinely for forest inventory and local resource assessments. The U.S. Forest Service participates in the USDA National Agricultural Imagery Program (NAIP), which collects one-meter digital imagery on a five-year recurring basis. This imagery is used in mapping various resource conditions. Other than its use as an important mapping aid, NAIP's ability to determine resource conditions for fuel loading and forest mortality is very limited. For project-level planning, finer resolution imagery is required to achieve the desired assessment of forest resource conditions.

Forest Service and other cooperating field units often utilize digital high-resolution satellite imagery for local forest resource assessments. An example is a spruce-beetle mapping effort conducted in the early 2000s using one-meter and 0.6-meter satellite data. Dead trees were discernible in both resolutions of imagery; however, recently dead or dying trees (known as faders) were not discernible in the coarser one-meter imagery. To guide many insect and disease mitigation measures, the location and number of faders are needed. In addition to the identification of faders, identification of tree species and sub-canopy is often needed, and imagery with a resolution finer than 0.6 meters is required for these determinations. The imagery resolution of choice from our field practitioners is in the six-inch to one-foot spatial-resolution range. As of this moment, airborne imagery, usually photography (as opposed to satellite imagery) remains the imagery of choice for most field foresters.

The Research & Development arm of the Forest Service has been experimenting for several years with using Light Detection and Ranging (LIDAR) sensors. Similar to radar but using a laser instead of radio waves, LIDAR provides very high resolution images. Researchers are combining LIDAR with very accurate Global Positioning System (GPS) data to map stream channels, including pools, riffles, and down woody material that are essential to understanding the health of aquatic habitats, and forest canopies. LIDAR imagery can see beneath the over story, allowing researchers to map under story plants and help detect places where trees have been removed, such as through thinning operations.

Pre-visual detection of stress on individual trees is currently a major focus for forest health remote sensing specialists. In order to intervene early in a pest outbreak scenario, early indications of pest infestation—such as tree health at the edges of known infestations—are important. This is especially true for exotic invasive species. Unfortunately, at the present time we do not have a mature repeatable technology to fulfill this need. Hyper-spectral data for host mapping or tree health mapping has the potential to fulfill this need, though at the present time results are inconsistent. Alternatively, field surveys can be conducted to map positive detections and to identify pest. The surveys are conducted with global positioning system (GPS) coordinates and tree health ratings. However, early infestations are often missed during field survey as damaged trees initially are characterized by very subtle changes in the tree canopy. Trees stress signs, while present, often go undetected until they become obvious to the field specialist on-the-ground. Hyper-spectral imagery has been utilized by the Forest Service for limited developmental projects for stress-detection, and its use may be increased as the technology development progresses.

Proximity of Forests to Development that May Effect Forest Health

Urban and suburban growth has resulted in the development of an outlying metropolitan fringe that extends into rural areas with attractive recreational and aesthetic amenities. This is especially true for urban growth near forests. This land-use change has significant implications for wildfire and pest management. The WUI creates an environment with an increased likelihood that wildfires or pest outbreaks will threaten structures, trees around homes, recreation sites, and people. The spatial extent and location and, most importantly, the growth of urban and suburban areas are information that is sought by nearly all sectors of the natural resource management community.

A myriad of geospatial technologies—including geospatial modeling of census data, the "city lights" data set from the National Oceanic and Atmospheric Administration's National Geophysical Data Center (NOAA/NGDC), and virtually all other remote sensing platforms mentioned thus far—are used to conduct analysis of the WUI at different spatial and temporal scales. This is typically done on a project-by-project basis with the structure density threshold varying accordingly.

Development Efforts and Refinement

The Forest Service has long used various remote-sensing methods to assess forest health and detect damage, and continuously investigates new technologies as a strategic and tactical aid to natural resources management. There are advantages and disadvantages to all such geospatial technologies. It is imperative that the right platform, imagery, and analysis be matched to the specific problems that natural resource professionals face. Remote sensing technologies have extended the ability of resource specialists to assess forest conditions, and these technologies are increasingly being used at various spatial and temporal scales to address natural resource management questions.

The future possibilities of "fusing" data from satellites with airborne LIDAR imagery and precise GPS coordinates offer great future potential for developing better maps in the future. In particular, the ability of LIDAR to create three-dimensional images of forest stand conditions instead of just the flat overhead look from satellites offers substantial promise for improving natural resource management.

Data acquisition and analysis in any form still requires a considerable investment of resources and expertise. The Forest Service continues to improve its suite of hardware and software tools for processing and analyzing remotely sensed data. Most national forest field offices now have such hardware and software, and are improving their expertise in using GIS or image analysis software to process and analyze geospatial data sets. Land managers are also improving in their ability to select appropriate remote sensing technologies to address their data needs, and they are supported by technology transfer efforts of the Remote Sensing Applications Center (RSAC), the Geospatial Technologies Service center (GSTC), and FHTET.

What are the benefits of using remote sensing data over data that are acquired by other techniques?

Remote sensing methods are effective tools to assess fire, forest pest and forest conditions. One of the benefits of using remote sensing data over data acquired by other techniques (for example, aerial survey and ground survey) is the spatial precision which allows for the analysis of other resource concerns, including the presence and distribution of threatened and endangered species or the occurrence of multiple threats through time. Also, ground surveys are often not cost-effective over very large areas. Another benefit of remote sensing lies in its consistency and objectivity; the data do not pass through the subjective filter of a human observer before being recorded. Compared with a ground survey, once collected, remotely sensed data can be easier to process and analyze, can cover more ground, and thereby reduce analysis time and improve overall planning productivity.

What, if any, are the challenges and impediments to the use of remote sensing data for these and other applications, and what are your recommendations for overcoming those barriers?

Performing remote sensing data analysis requires a wide-range of skill sets, from basic repetitive tasks to high-end analytical support. A typical field user of remotely sensed data needs to perform the full spectrum of skills from basic through advanced. Often, the skill-level for the advanced use of remote sensing technologies is very limited at the field level, though regional offices and national service centers can and do provide support for individual projects.

Basic tasks for the analysis of remotely sensed data are usually performed by technician-level employees. This capability has diminished over the last few decades as the workforce has shifted from technician-level employees to professional and administrative employees. Often, a field unit is left with little or no support for basic remote sensing processing—a field staff officer may be doing the work of a field technician due to staffing limitations. As these remote sensing skills evolve through workforce evolution, skill sets must continue to improve for the utility of remotely sensed data to increase. The national service centers for remote sensing applications (RSAC), geometronics (GSTC) and forest health (FHTET) are all working on technology transfer efforts to develop field ready methodologies, and improve workforce skills to meet today's needs.

The early signatures of most forest pests are ephemeral and the timing of data acquisition is another important challenge. Imagery must be acquired during the period of time during which pest damage signatures are most visible or when the information best supports managerial action. This is very often a very brief period, sometimes less than two to three weeks. Imagery acquisition during this "bio-window" is difficult in some parts of the country due to imagery acquisition schedules and the lack of suitable weather without clouds. Also, the effectiveness of on-the-ground treatments for a given forest health concern involve data timing considerations. Results from image analysis must be timely in order to facilitate time-sen-

sitive on-the-ground treatments. Remotely sensed data need to be collected, processed, and evaluated within a given timeframe so that the forest health concern is observed and a response can be formulated and performed in a timely manner. For tactical on-the-ground operations, the required turn-around time of imagery acquisition, image analysis, and treatment prescription often exceeds the biological window available for the treatment to be effective.

Shortening the time to analyze remotely sensed imagery would significantly aid in the practical implementation of remote sensing in the U.S. Forest Service. Efforts to develop ways to reduce this time could be accomplished through close cooperation of remote sensing commercial interests, researchers, field resource specialists, and the technology development community within the U.S. Forest Service.

What remote sensing data, products or services, or supporting infrastructure would be most valuable for expanding the use of remote sensing data in the future?

The key to providing continued support for the mid-scale mapping and on-going forest condition monitoring is Landsat. Continued availability allows for the comparison of current conditions with reference conditions collected by previous Landsat sensors to identify changes and trends in forest canopy, including the new challenges associated with global climate change. Landsat imagery has been a significant component within our natural resource information programs. Trends detected through such an approach will yield insightful information which otherwise would not be detected through other monitoring techniques.

In order for high-resolution satellite imagery to be more routinely used, it must achieve finer resolution and be cost-competitive with aerial photography. Higher resolution remotely sensed data (airborne or satellite) can be utilized when determined to be cost-effective for the extent of coverage needed. Often, a project's spatial extent exceeds the practical capability available given the small image "footprint" of various sensors. Also, the cost of high-resolution satellite imagery must match the project area and not be cost-prohibitive. Lower-cost imagery (assuming useful interpretation) would ultimately yield better, more frequent monitoring of our forest resources.

The development of automated routines for preparing and interpreting imagery would help to shorten the turn-around time between imagery acquisition and treatments. This can help reduce the need for basic interpretive skills and improve the timeliness for deriving analytical information. Professional field specialists could then better focus on problem-solving, for which they are most skilled: that is to make natural resource decisions.

Image interpretation relies upon assigning certain characteristics, such as tree species, to specific parts of the image-a process called classification. Building accurate automated routines to classify an image requires sufficient data from ground plots to validate the classification routines.

Conclusion

The USDA Forest Service utilizes remote sensing and other geospatial technologies routinely to measure resource conditions. This is done both to assess current conditions and to predict future conditions. Assessments range from the strategic to the tactical and utilize imagery from a broad scale to a fine scale. Remote sensing technologies range from analog photography (true color or color infrared) to the latest in hyperspectral imagery. Acquisition platforms range from government-owned systems to commercial systems. The agency maintains an active technology development effort and continually tries to fit the task at hand with the various remote sensing methodologies available. Sensor capabilities (spectral, spatial, temporal, and cost) must be carefully tailored to the project; if a match can be made, the Forest Service will likely use that technology in their resource assessment efforts.

Mr. Chairman, this concludes my prepared statement. I would be happy to answer any questions you or other Members of the Subcommittee may have.

Acronyms and Abbreviations

FHTET—Forest Health Technology Enterprise Team

GIS—geographic information system

MODIS—Moderate Resolution Imaging Spectro-radiometer

BAER—burn area emergency rehabilitation

ASTER—Advanced Space-borne Thermal Emission and Reflection Radiometer

AWiFS—Advanced Wide-Field Sensor

LCMMP—Land Cover Mapping and Monitoring Program
NAIP—National Agricultural Imagery Program
UAS—unmanned aerial systems
WUI—wildland-urban interface
NOAA/NGDC—National Oceanic and Atmospheric Administration/National Geophysical Data Center
RSAC—Remote Sensing Applications Center
GSTC—Geospatial Technologies Service Center

DISCUSSION

Chairman UDALL. Thank you, panel, and we want to move right to a round of questions, and I will recognize myself for five minutes. I want to ask a very basic question, and each one of you have spoken here, but I wanted to give you a chance to underline the importance of this data.

What makes the use of remote sensing worthwhile for what you and your organization do?

I want to start with Mr. Byers, and we'll go on with Dr. Montagu. Byers is a very well-known Colorado name. Are you related to former Governor Byers and the town of Byers and all the other?

Mr. BYERS. I would like to say yes, but I'm not sure that I am. You know, I try not to say that too often, so that folks—I'm very proud of what the Byers family did in Colorado, even if they weren't directly related to me. I'm sure there's something there.

Chairman UDALL. I'm sure you are. Middle Park in Grand County, which I represent is one of the most beautiful landmarks, Byers Peak, which draws the eye immediately when you come up over the pass.

Having gone off on a bit of a tangent, Mr. Byers, tell us how remote sensing data makes what you do worthwhile for you in your organization.

Mr. BYERS. That's all right, Mr. Chairman. I think you have the license to do that when you choose.

This actually is—it is very serious to us because, as you know, many of the State agencies are limited in funding here in Colorado. We have a number of legislative initiatives that have kept our growth of our budget to a limited area. The real value that we have is that we get a great deal of data, very specific and high-resolution data. It allows us to spend less time ground truthing information, allows us to use less public funds in the general administration of water rights for us, primarily, and I'm speaking of the Landsat technology that I spoke of earlier.

The other aspect of it is, is that we tie into all of this. I act as the emergency manager within our department and a number of other things. We tie into all of this other technology, and all of it saves us time, effort, and gives us better information faster, and allows us to respond to the public's needs better. With that, I'll stop.

Chairman UDALL. Dr. Montagu.

Dr. MONTAGU. I want to focus on one specific technology, and mainly aerial—digital aerial photography. Obviously, the Denver metro area is growing significantly and has been now for over a decade. We're adding about 20,000 households a year. I may get that wrong.

The overall growth of the metro area, you know, trying to plan for that and manage it so that we can put in the long range infrastructure requires that we have some sense of where this growth is happening, and also develop some policies that hopefully direct some of the growth and match the infrastructure that we're trying to build.

Aerial photography is critical for that, particularly, number one, knowing where that growth is happening, but also for change detection, being able to look back and forth through time to see where that growth is. So it's vitally important to us that we keep that going.

We have formulated our own approach to that, which is this public/private partnership that we have going. We have 30 different agencies working collectively to acquire this imagery together. I'm pleased to say that both the State of Colorado and the USGS have partnered with us on that, developing that together collectively.

Chairman UDALL. Thank you. I'll let the record note that I prefer DRCOG as the acronym.

Mr. Navarro, please.

Mr. NAVARRO. Thank you.

The value, obviously, is being able to get to the location with the centerline data that geospatial imagery gives us. But leveraging that technology to also be able to layer for those response agencies on specifically what it is they're looking at, to get a specific address, then we know what's in the building, or have a full deck on final analysis that geospatial creation will provide.

Now, the other aspect of that interface is that any fire professional will tell you that weather is the major factor. But then you have to layer in slope and terrain in the location where you'll be able to get good, accurate information relative to that vegetation layer when you get there, because oftentimes these teams will come in from across the country, and it's vitally important to the safety of mitigation.

Chairman UDALL. Mr. Sapio.

Mr. SAPIO. Remote sensing methods are effective tools to assess fire, forest pest and forest conditions. One of the benefits of using remote sensing data over other techniques (for example, aerial survey and ground survey) is the spatial precision which allows for the analysis of other resource concerns. Another benefit of remote sensing lies in its consistency and objectivity; the data do not pass through a subjective filter of a human observer before being recorded. Remote sensing data can be easier to process, analyze, and covers more ground, reduces analysis time, and improves overall planning productivity.

Chairman UDALL. Thank you.

At this time I want to recognize our Ranking Member, Mr. Feeney, for his questions.

Mr. FEENEY. Well, thank you to all of our witnesses. I think Mr. Byers suggested that there may be a gap should Landsat 5 or 7 fail prior to launch of the Landsat Data Continuity Mission in 2011. If that gap occurs, how much of a problem will it be for what you do, and some of the other witnesses, and can that gap be mitigated by surveillance, airborne surveillance assistance, if we're going to have a gap.

Mr. BYERS. Thank you, Mr. Feeney.

Mr. FEENEY. Bring that closer.

Mr. BYERS. Our view, as we look at this collectively with the western states as well as within Colorado is that, yes, there are opportunities for us to cover the gap. But the costs and the efforts associated with that are detrimental to the overall well-being of the public. We have the opportunity here to assure continuity, and an efficient and effective way to do that, should we have a gap, should we have a problem.

We believe one, we've wasted the opportunity that is presented in front of us to get this sensing instrument up in space. The other one is that the next time we're able to do that is considerably farther down the road, and the expense to all of the public agencies is going to be extreme. And the problems we have facing us in the west with climate change, and just all of the land and water issues. Water here in the west is so valuable and so critical to life. When I worked with the tribes, water is life, and that's how they would explain it. And that's how it is here in the west. And that's why it was so important to us to see how—see all of this information so that we can manage our water resources collectively in the best way possible.

Mr. FEENEY. Anybody have anything to add to that? Mr. Sapio.

Mr. SAPIO. The Landsat program has been a real workhorse in monitoring vegetation and vegetation change. Landsat 5 and Landsat 7 are operating well, well beyond their design lifetime.

Landsat continuity is key to providing support for mid-scale mapping for forest services, to monitor ongoing conditions, and to address new challenges associated with drastic forest changes that we're seeing here in Colorado.

Landsat or other Landsat sensors will also be useful in evaluating vegetation changes in climate. Continued availability of this kind of imagery, the short wave, red band in particular, allows a comparison of current conditions with reference conditions already provided by thousands of previous Landsat collections. An example of this would be the Aspen incline in the west of Colorado.

Mr. FEENEY. Thank you. I have an interest in, given the capabilities of this optical scanning equipment, whether privacy issues have been raised and to what extent, and to where—I don't know for those over here or in California, but in Florida we have sunshine laws that virtually aid in protecting the public. Ongoing criminal investigations, for example, are totally accessible with few exceptions to the public, to the press.

And so how do you deal with privacy, and are there concerns, for example, with tourists, or evildoers would get, you know, whether it's a nuclear plant or whatever it is, to get access to some information that would be useful in doing harm? You know, technology is morally neutral.

It can be used for good or evil, and I want to know to what extent you folks have dealt with those questions.

Mr. BYERS. Thank you, Congressman. We have—we certainly, from a water management standpoint, believe that the transparency is important. We think that California ought to know what Colorado is doing, and we certainly would like to know what California is doing with our water, tongue in cheek there a little bit.

We think that's a good thing, and here the Colorado, we do have open records and such.

However, as I've mentioned, I work several hats. I also sit on a government coordinating council with the Department of Homeland Security for dam security. And we are very concerned about how much of this aerial information is available. But the fact of it is that most of the location information is already out there. We do a very good job of looking at how to deal with security issues on individual structures and regional areas.

Like, for example, we will look at how all of the infrastructure and protection of the infrastructure with the Democratic National Convention coming here in Denver. We've already started much of that work. We also do it all across the U.S. as a national look. We watch carefully from Colorado to look at who's asking for the information so that we can provide that information to the appropriate authorities.

But as far as the transparency of the information, we don't view that as a problem. Transparency is a good thing. Folks knowing what kind of crop issues, how water is managed, what climate change issues to look at, topography, all of that stuff we think is a good thing.

We think it has, actually, very good application to the southwest with the recent drought and some of the issues they've had to deal with. We think it has great application there, and I'm sure it is used.

Dr. MONTAGU. It's a very critical issue in terms of all of this data that is available now. And I know it's a subject of conversation across this consortium that we have—like I said, we have 30 different local governments, utility companies, and some members of private sector all getting access to this data, and we talk a lot about the privacy concerns of it.

I think Mr. Byers is right. It is a transparency question in the sense of the public value that comes from it, from its dispersion is more important than the potential for nefarious use down the road. And the fact of the matter is, there's so much of this data out in the public domain now, that the ability to stop it at this point in time would be very difficult.

That said, though, I know that all of our member governments treat this data very carefully, and it's—you know, the security that goes with all of those sorts of things, that's something we all take seriously to make sure it doesn't end up places we don't want it to. And we do have tracking systems that go through a process that tracks where this data is going.

Mr. NAVARRO. That's a great question there. We've wrestled with that internally, officers at our command in that part from south central region that individually facilitate that within that office. We have a grant from Federal Government for planning for terrorist responses. We use a tremendous amount of GIS information and we share that with our partners. So we've been very careful, relative to those agreements within in our group on how the data is used and how it's shared. But the reality is some of that data is public data.

I think, if we look at it as the data is a tool, which individuals can get access to, how we plan based on that data is really more

sensitive to us, rather than just the data itself. It's the great thing about living in America, and the lousy thing about living here.

Mr. SAPIO. In my experience, I hear a lot about this, but I haven't run into any practical situations where it's been a problem for us in the Forest Service. The nature of collecting the data over remote forest areas, we're not collecting overseas. The data is commercially available, and it's available in the public domain. We're bound as federal employees to protect personal identifiable information, and trying to do so. So if there were a situation for that to arise, I would imagine we would find a way to work around it.

Mr. FEENEY. Mr. Chairman, I'm way over my time. But if I could just note that, again, technology is morally neutral, and a lot of it is already out there. But for example, somebody that wanted to do a lot of harm could look at the dryness patterns and which way a wildfire was likely to grow. Somebody would know where to drop most of the poison if they wanted to do harm. And you can go on the web site and punch in my address and get a 360 circular picture of my home and anybody that wants to break in a home. So it is scary. I don't know what the answer is, but I thought it was an important question.

Chairman UDALL. I think that's a very important question. I think it was an important discussion and we ought to continue it. And there's obviously more we need to understand.

We're going to do a second round of questions, and I would like to come back to the four of you and ask you what opportunities you foresee for the expanded application of remote sensing to your work and what's needed to realize those opportunities. I know some of you have spoken about that with Landsat and other technologies, but please take—if you had a wand, what else would you like me to do?

Mr. BYERS. If I had a wand, I'd like to know what the snow pack is going to be next year this year. That is what I'd really like to know. And speaking of snow pack, some of the opportunity that we see is with our evaluation of the snow water equivalents and the distribution of snow pack in the State of Colorado.

We have certainly—currently working on a snow program, which is a cooperative program with several federal entities as well as several entities within State government. And one of the things that we look at is trying to have a better—because that water supply is so important to us, as well as the rest of the west, is trying to look at how do we get a better handle on what's there and what kind of distribution, what kind of timing we'll have with respect to runoff. Of course, again, all of what has been discussed today is very important to the State. We've focused a little bit on water in the Subcommittee hearing, and we appreciate the opportunity to do that.

Dr. MONTAGU. My crystal ball would have the tools and the processes in place to start to integrate a lot of this data together. We have collected a lot of stuff over many decades now that we typically tend to use for specific applications. But in reality, we can start to look at our urban and our rural environments much more holistically. We can start to blend some of these data sets together.

Understanding the health of urban vegetation, for example, is very important for understanding the impacts of climate change

and the likely heat effects that happen in urban environments. So being able to draw some of that information together with some of the long-range plans that we're producing will allow us to leverage this information much more efficiently going forward.

Chairman UDALL. Is that a function of software? Is it a function of the digital resources to bring those data sets in closer proximity.

Dr. MONTAGU. I think it's a function of a whole range of things. One is starting to draw expertise together to say we need to look at this more closely. The other one is starting to rethink a little bit about how we use this data. So we put up these sensors for a specific purpose when, in fact, we could be saying we need to be more holistically looking at the number of different applications we can use it for.

Mr. NAVARRO. You know, I was very interested in comments just made, because it's really the page that we're opening up recently in Washington, talking with some of the representatives from DHS from the standards and technology group and the data group.

The fire service itself, I'm on an advisory committee, and we're trying to formulate a standard by which we produce this data and use this data. One of the conversations we had, relative to that, was what's the output? What is that going to look like? What's the utility of using that particular data? But on the long view of that, from my standpoint, from leadership in the fire service, is we have to start educating the fire service itself and the technology that's there and how that's going to be used. Bring it to that leadership, whether it's the city manager, or mayor, or local fire chief, how does that get used in a holistic fashion?

That's going to be a very interesting migration as we go forward.

Chairman UDALL. Mr. Navarro, I'd like to pursue that more in commentary. As you know, I'm a homer. I talk a lot about what you all have done down here. At the risk of getting you in a little bit of trouble with your fellow fire chiefs, how many other departments, how many other urban areas, how many other cities are at the point you all are in using this data to prevent and then respond, hopefully not necessary, but if the case does arise.

Mr. NAVARRO. None that I know of to the extent we're doing that. We had an IT section in my administration when I arrived here in '94, but we do have a very large group that's been formed of users. Chief Rector over in California, and the California Fire Service is very interested in accumulating this information, and how it's going to be leveraged on the other end of it. So we're starting to open up that page.

We actually hosted a meeting there two weeks ago, of the practitioners, to try that standard process, and the advisory committee is looking at that right now. But we've got a ways to go. We've got to catch up with what DOD has been doing for years in terms of situations where—much the same, our warriors are in the field doing something a little bit different.

Chairman UDALL. I was on the Elk Meadow fire that same summer we had the Hayman fire. Supervisor Cables was there, Mr. Cables, and he said, Mark, the best analog here is to fight another war. This is a war-like environment, realtime situation. So your analogy, as well, makes real sense, Chief Navarro. So I'd like to get a breakdown of what you're doing.

Mr. NAVARRO. I encourage you to do that as much as you can.

Chairman UDALL. Okay, thank you.

Mr. Sapio.

Mr. SAPIO. With the temporal regulation groups, various commercial entities, we're likely to use the technology more and more, resolutions, temporal and spatial. If there were more preprocessed imagery routines available where features have already been extracted in the commercial sector, we're more likely to see casual users use LIDAR remote sensing imagery so they don't have to go through the training and the large amount of image prep necessary to extract information from the imagery.

One thing that's particularly important to my group in the Forest Service is that if there were vegetation information available of the city, that would be extremely useful for us to model the risks of insects and diseases that could be introduced at those industries. So those are the things I can think of off the top of my head that would make remote sensing more useful to the Forest Service.

Chairman UDALL. Well, it's exciting to hear all those potential applications, obviously. We have a bit of homework and additional work to do, and other resources, and continue to work together, which is why I'm, to provides a lot of opportunity.

The Chair recognizes the Ranking Member for another round of his questions.

Mr. FEENEY. Well, thanks. You know, Mr. Navarro, talking about the lead you have in using this technology, the—one of the aerial vehicles in California, Oregon and Washington, we have a series of serious fires, and it would help if I got a pinpoint accuracy in terms of what the direction of the fire was going. Obviously, this is valuable capabilities, even though you talk about firefighters having to make instant decisions and how accurate the information is.

What organizations, nationally, can you use to share these capabilities, and not just in fire, but maybe Dr. Montagu or Mr. Byers, what organization in city and local governments are addressing this in your conferences or charters?

Mr. NAVARRO. We actually are going to be on the docket for FRI here in Denver with—and I don't brag for myself. I'm probably the lead individual in GIS within our organization. And what we're able to do is we had some very expert technical advice, married with some operational folks. And as they sat down, they started a vision with what this technology can do. And that's how we've been able to launch some of that.

That discussion is going to be taking place at FRI. We're looking at what that agenda might look like to be able to convince. Because when you're talking leadership, they're very pragmatic about things. They know what works and what doesn't work. They don't want to try anything that's not going to work for them. The obvious kind of thing is, as part of the papers, you know, we're impeded by 100 years of tradition. But the reality is, if it works, they're going to start using it. We have to show the utility of that information.

If you provide a great deal of data that's not in a processed form, for someone trying to make discreet decisions very quickly, they're going to disregard it.

It's got to come in a form that makes some sense to them. The reality is that that hasn't happened too often.

California, I think, is a great example of what just occurred, because they were given a realtime situation like this. And I can't tell you how valuable it would be to have that base layer really knowing what was out there before, and then video from my global on what's happening on the ground, to be able to move resources around, be able to do the evacuations and do the other kinds of things.

Those large fires cannot be managed. They are going to burn until the weather stops. That's one of the problems for firefighters that's interesting. We are subject to some horrific fire behavior in this State if we don't do something about that. On the response side of that, we can provide some safety for those individuals that are going to be doing that, in terms of either evacuation or real response. So I hope that answers your question.

Dr. MONTAGU. The key point to make about DRCOG is, you know, we are a long-range planning agency, so we don't typically deal with tactical short-term stuff. The need for realtime information is not as critical, at least in the land use. I'll address the transportation side in a little bit.

But one of the concrete examples I can come to is the LIDAR that we are collecting at the moment for the Democratic National Convention is being used by the NGA in a tactical response. So they want to know all of the planning that goes with the security around the convention. But that information, when it flows back to us, we can start to create these three-dimensional models of the city.

One of the things that a lot of people struggle with is trying to imagine what something will look like 30 years from now. So being able to take that data and combine with the software that we have and create a vision of what the future might look like is very important to them.

Mr. FEENEY. Well, it's interesting you say that, because while we don't have a model of geospatial imaging, we do have a national model for simulation. We make everything from Tiger Woods golf to football. My nine-year-old tested it the other day, and I was sworn to secrecy about what was in it. We have all five branches of the military. We create the software there, and one of the things we have to put together here is the geospatial stuff. It's a great history of what's happening now.

What simulation can do is tell us what's going to happen next, and can train people, you know. You could run a wildfire in the offices in front of computers and test every commander in Colorado based on his or her behavior and get a very good picture of that wildfire many times before you actually had to fight it. And every one of them would be an A plus student by the time you actually have a real fire. It's an interesting possibility.

I have no further questions. Thank you.

Chairman UDALL. I'm going to hold a third round with a focus on—Mr. Feeney has questions, do it in 10 minutes, and we have paneled the next people. But if I might have each one of you talk to what you think the most important role for the Federal Government is in facilitating the use of remote sensing data to support

both public- and private-sector activities in the war-fighting campaign.

Mr. BYERS. First of all, give me a chance to really think my thoughts through.

Chairman UDALL. The next panel I'll alternate. I learn as I go.

Mr. BYERS. With respect to the Federal Government, I think that when these issues are beyond an individual State's borders, when they are, in fact, for the public good, that that's where the Federal Government comes in and has a role in coordinating the acquisition of the data, trying to work with how to utilize the data, and I think even through the education and exposure of various tools, of how to use and how to integrate some of that data. So I think that when it's the overall public good, that's where the Federal Government comes in.

When I think of it from a more local perspective, obviously, to use that same role would be that the State has a responsibility, particularly in its region or, for example, with us for the Western States Water Council, or a particular technical area, whether it is in the dam safety arena, whether it's in the forestry arena or whatever, to be able to be a facilitator and focus for getting some of that coordination between the Federal Government and the local and the hands-on practitioner.

But I think there's a variety of roles as a collaborative effort, a cooperative effort, and we have to continue to stretch each other's comfort so that we are pushing the envelope. And maybe that's the best scenario when I talk about this being, you know, kind of space. We do need to continue to stretch that envelope and go to new frontiers.

Dr. MONTAGU. I come back to the comments that I made in my testimony. It really is about leadership. The Federal Government has led this industry for a long period of time. And thinking of it from the point of view of a local government and a regional government, the cost not only of the direct acquisition, but also all of the R&D that goes in behind that is something that only the Federal Government is really resourced to do.

And, you know, Mr. Byers' comment about the expanse, the fact that this is broad acre stuff that we're talking about here, so it transcends local, regional, even State boundaries. So to have the federal involvement and leadership on that front is vitally important.

I think that the leadership on the distribution side, the models that the Federal Government is coming up with now to push the stuff out to people is very important. Again, we're talking about terabytes and terabytes of information that none of us locally can afford to store. And so to have those resources distributed across the country and being able to tap into those is vitally important for us.

Chairman UDALL. Chief.

Mr. NAVARRO. The lead agencies, in my estimation, on the federal side for some of the work that we do is DHS, FEMA and National Fire Administration. And for years we really didn't have that support, that a disaster or a local emergency basically was a local emergency, and at some point it morphed into this other thing.

I think back to the '60s when I started, and we had actual civil defense folks working in fire service because we had a national emergency because we thought we were going to get nuked at some point. That went away. Now we have a national threat again.

I think that we can partner with DHS, with FEMA, and with the National Fire Administration to alleviate some of the issues we had in terms of response mitigation at a local level, but also migrate that to the larger level. Because it starts here and it goes to there.

We don't have the resources at a local level to be able to do this, whether it's the staff, the technology, whether it's the process piece of it and integrating it into what we do. And I think we need to see the leads coming from the feds to help us with that. But we have a common purpose relative to those types of responses. DHS and FEMA do come in. The reality that they're going to be interfacing with the locals, they need to have situational analysis that we should be able to provide, and vice versa.

Chairman UDALL. Mr. Sapio.

Mr. SAPIO. There are four things that come to mind that all would be done under the umbrella of both partnership with other agencies and commercial entities in remote sensing. One that's very important is a provision of imagery and its distribution, which you've heard already. The provision of extracted information from imagery, like fuel loadings and pest risk. Thirdly, the provision of new analytical techniques. This would be particularly useful for local assessments, if we learn how to produce some extraction for a particular risk factor that's useful locally. And fourth, the provision of models that project future resource conditions, and this would be particularly useful for planning.

Chairman UDALL. Thank you. I note that all of you, in a sense, have talked to the opportunity here for two-fers or three-fers. And Chief, you talked about the civil defense needs in the '60s. And now, in a sense, history is repeating itself with a different kind of enemy. And then the role FEMA plays in their own like self-interest, and having the data they need when they're called to be on the ground. I know, Florida, Colorado, Mr. Feeney mentioned, have some similar challenges that Mother Nature presents, and the severity and the intensity which they can arrive.

But I think both, at the time, are partnered by setting aside what happened in New Orleans, that FEMA has begun to do a more preventative analysis, and preventative investments, and it seems like a very smart way to use federal dollars, as well as to draw in the local responders.

Mr. Feeney.

Mr. FEENEY. I've enjoyed all of the witnesses. I appreciate your testimony, and your advice. Thanks for having me today.

Chairman UDALL. Thank you for being here.

We'll take a couple of minutes, and the next panel will join us, and we look forward to their testimony. I know you all would be willing to answer questions for the record if we give them to you. Thank you.

[recess.]

Panel 2:

Chairman UDALL. The hearing will return to order. We have a wonderful, fascinating, erudite second round of witnesses, and I'd like to take a moment to introduce this second panel.

Kevin Little, he's the Director for Business Development for Intermap Technologies. To his left, Matt O'Connell who's the President and Chief Executive Officer of GeoEye. And we also have with us Jill Smith, who's the President and CEO of DigitalGlobe, Inc.

Again, I want to welcome each of you, and we'll dive right in and start with Mr. Little and his testimony.

STATEMENT OF MR. KEVIN LITTLE, DIRECTOR OF BUSINESS DEVELOPMENT, INTERMAP TECHNOLOGIES, INC.

Mr. LITTLE. Thank you very much, Mr. Chairman. We appreciate the opportunity to participate with you and your committee. I thought I would do a few visuals. I'd like to talk a little bit about what the applications really are from a real-world standpoint. What we have over here on the poster board, everyone has been referencing the Hayman fire. With this particular, the red is the color of infrared. False color can spot image.

And I'm sorry, we've got this thing going in the background. I wish we had more screens. Actually, the poster is what I'm referencing. It's actually an image of the Hayman fire. It's a 170,000 acre area. The technology that's the base layer does the slope aspect of the actual digital elevation while the wildfire is actually burning. That particular technology can actually see through the smoke cover.

We had to do the spot collection after the fact a few weeks after the rain had put the fire out. And we discriminate on the red there. The area that's red is the healthy vegetation. The other part, of course, is the burned area on the right side. And at the bottom, we were able to do a sloping aspect. And with that we were able to figure the mud slide, those sorts of things, vegetation burned, et cetera.

As mentioned, I am Kevin Little with Intermap based here in Denver. Do you want to fire up that other one, please?

Yeah, let's do this one. This is actually Yosemite, high-resolution elevation. I think this is actually DigitalGlobe imagery draped over the top. And what this is, we actually have a positional accuracy of X, Y and Z with this image, that actually you can use this in a handheld device. It's all commercial. It's all very user-friendly. We wanted to use this one because we know how you have probably climbed that in the past several times.

Chairman UDALL. I have. Don't hold it against me. I did kill a lot of brain cells on the mountains.

Mr. LITTLE. Perfect. Scott, if you want to kill that one. Another one I want to know is on this poster over here, the NEXTMap Britain poster, if you could. From an application standpoint, collecting commercially throughout the whole country.

This is all in Scotland. It's cloud free. That's an initiative right now collecting all over the U.S., which we're at about 65 percent of that whole collection right now with this same level of accuracy.

What we're showing is, we're utilizing very substantial benefit. It's not just one specific technology. And if there's one thing I could leave you folks with today is the idea that applications that are fit for purpose. It's not technology specific. It's more application specific. There are actually areas where you need to have high-definition satellite imagery. For instance, in doing city centers, doing ports, doing choke points on borders, those sorts of things. Having that revisit with a high-resolution commercial satellite system is a wonderful thing.

Some of you heard people talk about the LIDAR application today. LIDAR is a very wonderful technology more designed for smaller areas. So we're looking for, perhaps, coastal areas, sometimes city centers and other flood areas. The radar technology that's been used in the past, which is what Intermap utilizes, is good for broad area collection of high-resolution digital elevation models, if you will.

If we could look at Merrill Pass, Alaska. This is actually a program that was done in conjunction with Space Imaging back in the important part of GeoEye. So the high-resolution imagery is the Space Imaging stuff. The terrain is the Intermap. This is in conjunction with FAA and with NASA. This Merrill Pass, Alaska area, people take off out of this airport, fly into this area. They get stuck in the fog and they run into the mountains.

So what we're able to do here with my handheld GPS, in a position where we are in relationship to the terrain. So once again, this is a combined product, if you will, with some real-world applications. We know within a meter, plus or minus on the X and Y, about one meter on the Z of the altitude where we're at in conjunction with this line. And the line that was drawn, this particular day, was going to be the wind's best approach through this valley.

Chairman UDALL. Where is that valley, just out of curiosity?

Mr. LITTLE. Merrill Pass is just due west of Anchorage. You take off from Anchorage International. They actually fly through this pass to get on the other side of the range. And some of these mountain tops are 14 to 20,000 feet tall. You have a little trouble getting through this area. It's not so bad in Florida. We could do a flight with this in Florida with no problem.

Next one I want to show here, Kevin if you don't mind showing, this is actually the coast area, the border area on the left, shuttle radar coastal imagery. California is on the north. The red line is the Mexican border. And Mexico, of course, is on the south. And what we have is on the right side is a one contiguous data set of the—it's 1.25 meter pixel of one meter on the Z, showing the applications for—this is to indicate the northbound. It's the Mexican border. We can do the Canadian border also.

I'm sorry, my red light came on.

Chairman UDALL. Why don't we leave it there, and we'll come back in plenty of time for other questions and you'll all have a chance to make more comments.

[The prepared statement of Mr. Little follows:]

PREPARED STATEMENT OF KEVIN LITTLE

Mr. Chairman and Members of the Subcommittee on Space and Aeronautics, Intermap appreciates the opportunity to testify before you today on: *Remote Sensing Data: Application and Benefits.*

Our CEO, Brian Bullock, extends his regrets in that he cannot attend this session, but wishes to convey his appreciation for the invitation to testify.

I am Kevin Little, Director of Strategic Business Development and Government Relations for Intermap Federal Services Inc., a Colorado company, and Director of Business Development for Intermap Technologies, Inc., both of which are headquartered in Englewood, Colorado.

Intermap is a remote sensing firm that creates and sells digital elevation models (DEMs) and value-added mapping products derived from our proprietary airborne Interferometric Synthetic Aperture Radar (IFSAR). Intermap operates its IFSAR systems throughout the world for various domestic and international customers, including the U.S. Government's defense and intelligence interests.

Intermap Technologies Inc. is a commercial, publicly traded remote sensing company with its global headquarters in Englewood, Colorado, with international offices in Europe, Asia, and Canada.

Intermap currently employs approximately 145 people in our Denver office and continues to increase the number of this high-tech workforce. Our total number of global employees exceeds 650 and also continues to grow.

Intermap Technologies was one of the first remote sensing companies to realize the value of collecting and archiving geospatial data for large geographies, and the first and only to collect country-wide elevation data on a global scale.

1) Please describe the ways that remote sensing data can assist public and private sector users in Colorado and provide benefits to State and local governments.

In the broadest sense, remote sensing is the acquisition of information of an object or phenomenon, by the use of either recording or real-time sensing devices that are not in physical or intimate contact with the object (such as aircraft, spacecraft, satellite, ship, buoy, or in-situ).

Intermap's technology is airborne specific and we work in a very complementary and synergistic manner with the commercial satellite companies. Satellite systems are easily deployed in areas where access is denied to commercial aircraft; however, technical capabilities allow IFSAR to be used in areas of extreme cloud cover and are able to accomplish their collection mission even at night.

Though the technology behind the manner in which satellites and airborne remote sensing companies gather their data are very dissimilar the "fused" product generated by orthorectifying satellite imagery with IFSAR DEMs produces a product unparalleled in its usefulness to the end-user, both civilian and defense related.

Remote sensing and the technology that is fit for purpose allows for the most rapid and accurate terrain mapping for country-sized areas. (See poster: NEXTMap® Britain) Utilization of these combined technologies provide substantial benefit for a wide range of real-world applications that may utilize the data for not only x and y position coordinates, but for the z—or elevation—coordinates as well.

Specific to the question of ways that remote sensing data can assist public and private sector users in Colorado and provide benefits to State and local governments, we offer the following real-world application:

The Hayman Fire Area: (See Poster)

The Hayman Fire in June, 2002, was the largest in Colorado's recorded history, destroying over 600 structures and burning 137,000 acres. Soon after containment of the fire, Intermap Technologies, in collaboration with Space Imaging (now GeoEye) and USGS, acquired IFSAR elevation data and radar intensity imagery of 22 7.5' quadrangles encompassing the Hayman Fire burn and surrounding areas while the fire was still active.

Intermap collected and provided reflective surface and bald-earth IFSAR DEM and Digital Orthophoto Quadrangle (DOQ) radar magnitude image data using single-pass X-band IFSAR for the Morrison and Cheesman Lake Quadrangles.

The USGS Rocky Mountain Mapping Center made the Intermap IFSAR data available to federal, State, and local agencies for use in post-fire recovery, remediation planning, and training.

Subsequent to the delivery of elevation and imagery data by Intermap, the USGS Rocky Mountain Mapping Center held workshops for stakeholders and users to illustrate the applications of the data sets.

Individuals representing 14 federal, State, and local agencies with interests in the Front Range and the Hayman Fire area attended these workshops.

The Hayman Fire Area: Flood Plain Mapping

USGS Rocky Mountain Geographic Science Center, used the IFSAR data set to update the South Platte 100-Year Flood Plain Maps. "The Hayman Post Hazard Mitigation Maps" were produced for FEMA for flood risk assessment purposes. The revised 100-Year Flood Plain of the South Platte takes into account the Hayman Wildfire incident, and assumes worst-case scenarios (lakes at full capacity level). These maps were also distributed to the Colorado Water Board and local county managers.

Alaska Aviation Safety Project (see Merrill Pass, AK fly-through video)

Another effort that combined commercial and government expertise to satisfy a real-world issue was the Alaska Aviation Safety Project (AASP), which moved from developmental stage to public participation. The Alaska Department of Military & Veterans Affairs (DMVA), NASA, the FAA, Anchorage-based E–Terra LLC, and Colorado-based Space Imaging and Intermap Technologies joined forces to provide Alaska aviators with the latest technology in flight simulation using Alaska's unique and challenging terrain. The program was designed to help lower the number of aircraft accidents in Alaska.

Address Specific Flood Risk Assessment: (see PowerPoint slides)

With the use of various remote sensing products including elevation data and aerial imagery, as well as utilization of existing building models, vector data and a proprietary storm-surge algorithm, individual buildings in the Commercial Business District of Miami, Florida were modeled on an address-specific basis.

The storm surge algorithm mimicked a Katrina-like event, with a three-meter storm surge with the duration of approximately three hours.

2) What role can remote sensing data play in homeland security and national defense?

Homeland Security & National Defense—

With the increasing awareness of Homeland Security issues, agencies that control and manage border areas, critical infrastructure, coastlines, and transportation "choke-points" are in need of an accurate, consistent topographic base map and corresponding high-resolution images.

The current maps and imagery available to agencies concerned about Homeland Security issues do not provide an appropriate level of situational awareness for policy development, planning, operational organization, and action.

Security decisions need to be made with the most accurate and current information available.

Among other considerations, IFSAR allows for better terrain mapping that leads to a greater knowledge and capabilities for all areas of mid-continent, coastal, and border areas of the United States, and has a unique value to Department of Homeland Security, State, county, and local authorities. Intermap is currently partnered on the Secure Border Initiative (SBI), a comprehensive multi-year plan to secure America's borders. (See poster: Comparison of Digital Surface Models)

High-resolution terrain data allows for better understanding of homeland security defense and planning measures (especially in rugged terrain areas that exist in states like Colorado and along the border areas), and provides a better visualization of all airport and military installation terrain issues. Following a calamitous event, whether a natural disaster or otherwise, commercial remote sensing assets can be tasked to evaluate an area and provide information concerning details of the event, magnitude of the event, evacuation planning, and plume drift and provide change detection. The responsiveness of these commercial assets was well proven following the Aceh Tsunami and Hurricane Katrina.

These remote sensing data sets are extremely synergistic and complementary.

3) What are the main impediments to the effective use of commercial remote sensing data for public sector application and what would you recommend be done?

The U.S. DOD has done an excellent job of tapping the commercial market to take advantage of technology advances, free market pricing and other similar opportunities. Commercial purchases afford the government better products at more competitive pricing. This is a win-win for the government and for the private sector, both contractors and end-users of the data.

FEMA has entered the final year of Congressionally appropriated funding of the Flood Map Modernization Program. Upon completion, map modernization will pro-

vide reliable digital flood hazard data and maps for 92 percent of the Nation's population, and easy access and sharing of that information.

In order to leverage the successes of map modernization and further enhance the usability and value of flood hazard mapping, FEMA has developed the Risk MAP strategy, which combines flood hazard mapping, risk assessment tools, and mitigation planning into one seamless program. The intent of this integrated program is to encourage beneficial partnerships and innovative uses of flood hazard and risk assessment data in order to maximize flood loss reduction.

FEMA, which has undertaken the extremely daunting task of remapping the United States for these applications, is extremely short on resources and funding.

Wherever possible, government agencies should couple their programs with other existing programs that are currently being undertaken and have shared goals, allowing them to satisfy their requirements and accomplish their mission.

It is important that the commercial sector be allowed to drive the technology in a manner in which all government entities may take advantage of these advances.

The entire map modernization program needs to embrace many remote sensing technologies that have a reasonable currency, meet a minimum specification or standard and are fit for purpose for applications.

These technologies include satellite and aerial photography as appropriate for cities, ports, urban change detection, and border choke-points, LIDAR for at-risk coastal areas and city centers, and IFSAR for large area collection.

Thank you for your time and consideration.

I am happy to address any questions the Subcommittee or guests may have.

BIOGRAPHY FOR KEVIN LITTLE

Kevin Little is Director of Business Development for Intermap Technologies, Inc. Intermap delivers high-accuracy digital 3D terrain data and related mapping products derived from interferometric synthetic aperture radar (IFSAR) (X- and P-bands) mapping systems to a variety of international customers.

At Intermap, Little is responsible for building relationships with new business partners on an international basis and the development of value-added businesses with Intermap's present customers. Little also supports sales of products and services to markets that include the Department of Defense and other government agencies, as well as aerospace, air navigation, aviation/simulation, insurance, intelligent transportation systems and other vertical markets.

Since 1991, Little's experience in the aerospace and remote sensing industry has included delivering solutions using multi-spectral, hyperspectral, radar and LIDAR data from spaceborne and airborne remote sensing systems. Little's broad experience extends to derived geophysical data products, data distribution and handling systems and decision support tools.

While serving in various executive-level positions in more traditional industries, as well as geospatial information technology companies, Little has been responsible for program management, business development, marketing and sales, government relations and corporate management on an international level.

Prior to joining Intermap, Little was employed at DigitalGlobe—purveyor of the highest resolution satellite imagery in the world—during the preparation and launch of its QuickBird 1 and QuickBird 2 satellites.

Prior to joining DigitalGlobe, Little worked for the Boeing Company on their start-up, RESOURCE21 program and was involved with development of its four-satellite optical array being developed for global Earth observation.

Chairman UDALL. Mr. O'Connell, the floor is yours.

STATEMENT OF MR. MATTHEW M. O'CONNELL, PRESIDENT AND CHIEF EXECUTIVE OFFICER, GEOEYE, INC.

Mr. O'CONNELL. It's a great honor to talk to you all about what GeoEye does to support the State and local governments, the defense and Intel community, the warfighters, and still provide value to our international and commercial customers. GeoEye is the leading provider of geospatial information, imagery and solutions. We help our strategic partners and commercial partners. We help them to better map, measure and monitor the world.

We have a constellation of Earth imaging satellites, and two mapping aircraft. Our constellation includes the .8-meter resolution

IKONOS satellite, and our new satellite, GeoEye-1, which we will launch from Vandenberg Air Force Base later this summer. It will be the world's highest resolution and most accurate commercial imagery satellite, imaging the world at .41 meters in color. And we will also have an international network of ground stations, a robust imagery archive, and an advanced geospatial imaging processing capability that's really the center of innovation.

GeoEye's imagery products serve the growing national and international demand of highly-detailed imagery in applications such as mapping, national security, homeland defense, emergency preparedness, urban planning, environmental monitoring, resource management and commercial fishery. In addition to operating imaging satellites, GeoEye's a worldwide leader in advanced image processing and photogrammetry. We produce a broad spectrum of imagery products from a wide variety of satellite and airborne sensors, both our own and other people's. We also create fused images, digital elevation models and land-use classification maps, and other image-derived products that help our clients to incorporate valuable information into any geospatial applications. We are a financially healthy and viable company, publicly traded on the NASDAQ, and our revenues are growing.

The remote sensing industry is not only strong and growing, we also play a critical role in supporting both national security and commercial applications. Many people on Capitol Hill realize that imagery from the commercial sector is the most cost-effective solution for the Nation's mapping needs, and that the taxpayer benefits when the U.S. Government buys imagery from the commercial sector.

Here's how it works. We make about 50 percent of our revenues from international and commercial customers. Those revenues provide a significant offset every time the U.S. Government buys imagery from the commercial sector.

As a result, it's a better deal for the taxpayer.

If the government builds its own imaging system, the taxpayer pays 100 cents on the dollar (possibly more when you consider the cost overruns of some recent programs). You could even say that we are subsidizing the U.S. Government because we provide needed imagery and services at lower costs than if the government attempted to perform the function in-house.

So by supporting the commercial industry, the U.S. Government receives several benefits. Our technology helps protect American lives. In addition, the technology to build our satellites can't be exported. It's located in states like Florida and Colorado. So when the U.S. Government buys imagery and products from the commercial sector, it is protecting the American industrial base.

You could say, in short, that by buying imagery from the commercial industry, the U.S. Government protects American jobs and protects American security at 50 cents on the dollar.

Through this partnership, the U.S. obtains technical leadership, which results in allies seeking our assistance instead of developing their own capabilities. Current U.S. policy encourages a robust commercial imagery segment, global leadership, and reliance on commercial imagery services, while discouraging the government competition with the private sector.

The commercial remote sensing industry fulfills the Department of Defense and the Intel community with mapping, charting and geodesy requirements at a fraction of the cost of national systems. That's why we believe that the industry provides the best value for the government's broad area collection requirements while still meeting the needs of our commercial and international customers.

Mr. Chairman, thank you for your leadership and for your commitment to the remote sensing industry. Our American workforce, coupled with leading-edge American technologies is going to continue to play a significant role in national security while creating new jobs and providing value to our international and commercial customers.

Chairman UDALL. Thank you.

[The prepared statement of Mr. O'Connell follows:]

PREPARED STATEMENT OF MATTHEW M. O'CONNELL

Good morning Mr. Chairman, Ranking Member Feeney, and Members of the Subcommittee on Space and Aeronautics. Thank you for inviting me to participate in today's hearing. It's a great honor for me to share with you how GeoEye supports the State and local governments, the intelligence community and the warfighters, while providing value to our commercial customers.

GeoEye is a leading provider of geospatial information, imagery and solutions for the national security community, strategic partners, and commercial customers. We help them to better map, measure and monitor the world. GeoEye owns and operates a constellation of Earth imaging satellites and two mapping aircraft. Our constellation includes the one-meter resolution IKONOS satellite, and our new satellite, GeoEye-1, which we will launch from Vandenberg Air Force Base this summer. It will be the world's highest resolution and most accurate commercial imagery satellite, imaging the Earth with a ground resolution of 0.41 meters or about 16 inches, and will be able to produce those images in color. In addition, we have an international network of ground stations, a robust imagery archive, and advanced geospatial imagery processing capabilities.

GeoEye imagery products serve the growing national and international demand for highly-detailed imagery in applications such as mapping, national security, homeland defense, emergency preparedness, environmental monitoring, urban planning, resource management and commercial fishery. In addition to operating imaging satellites, GeoEye is a world-wide leader in advanced image processing and photogrammetry. We produce a broad spectrum of imagery products from a wide variety of satellite and airborne sensors both owned by GeoEye and those of our customers. We also create fused images, digital elevation models and land-use classification maps, and other image-derived products that enable our clients to incorporate imagery into virtually any geospatial application. We are a financially healthy and viable company, publicly traded on the NASDAQ and our revenues continue to grow.

The American remote sensing industry is not only strong and growing, we also play a critical role in supporting both national security requirements and commercial applications. Many on Capitol Hill realize that imagery from the commercial sector is the most cost-effective mapping solution for the U.S. Government and **the taxpayer benefits. Here's how it works: we make about 50 percent of our revenues from international and commercial customers—so those revenues provide a significant offset in the overall price the U.S. Government pays for imagery and services. Consequently, it is a better deal for the taxpayer. If the government builds its own imaging systems, the taxpayer pays 100 cents on the dollar (possibly more when you consider the cost overruns of some recent programs.) You could even say that we are subsidizing the U.S. Government, because we provide needed imagery and services at lower costs than if the government attempted to perform the function in-house.**

By supporting the commercial industry, the U.S. Government receives several benefits. Our technology helps protect American security. In addition, the technology to build our satellites cannot be exported. Therefore, when the U.S. Government buys imagery products and services from us, it is also protecting the American industrial base. **In short, by doing business with us, the government protects American jobs and American security at fifty cents on the dollar.** It is through this partnership that the U.S. retains technical leadership which results in allies seeking our assistance instead of developing their own competing capabilities.

Current U.S. policy encourages a robust commercial imagery segment, global leadership, and reliance on commercial imagery services, while discouraging government competition with the private sector. The commercial remote sensing industry fulfills the Department of Defense (DOD) and the Intelligence Community's (IC) mapping, charting, and geodesy requirements at a **fraction** of the cost of national systems. We believe that the industry provides best value for the government's broad area collect mission, while meeting the needs of the user community.

Mr. Chairman, thank you for your leadership and commitment to keeping the American commercial remote sensing industry strong and vibrant. Our American workforce coupled with leading-edge American-developed technologies will continue to play a significant role in national security while providing value to our international and commercial customers. I look forward to your questions.

Testimony Submitted for the Record

There are multiple uses for commercial remote sensing data-to include providing assistance to public and private entities. You may be interested to know that we have almost a dozen partners in Colorado. The combined revenues of these companies exceed $20 million, and they support hundreds of employees in the commercial remote sensing industry.

While we do sell to the U.S. Government, we also **established the GeoEye Foundation which gives imagery grants to geospatial students and researchers. The GeoEye Foundation's mission is to foster the growth of the next generation of geospatial technology professionals.** The Foundation gives satellite imagery to students and faculty at select educational institutions to advance research in geographic information systems. To date, the Foundation has provided imagery at no cost to support land use studies over Mexico, polar ice studies in the Antarctic, and city planning studies over Jerusalem. The Foundation has also made grants to almost two dozen educational institutions and other non-profit organizations which include the University of Denver, Denver Metropolitan State University, the Plains Conservation Center in Aurora, Colorado, and the Mountain Studies Institute.

The Plains Conservation Center had a project aimed at prairie conservation; in particular, it focused on rattlesnakes. The Center surgically implanted radio transmitters into several female and male rattlesnakes over two years, and outfitted with a radio receiver, directional antenna, and GPS receiver, and tracked these snakes from spring to fall each year with the help of trained volunteers. Information about the micro-habitat environment of each snake's tracked location, as well as natural history data was collected. While the Center learned much about rattlesnake movements, it did still needed to see the snakes' movements visually using aerial views of the study site. This is where we came in.

The GeoEye Foundation offered a sharp, up-to-date satellite image of the study site to the Center without charge. From the satellite imagery, the Center could clearly see routes the snakes traveled in relation to specific vegetation types, geologic formations, and man-made structures. The image enabled the Center to compare snake movements relative to prairie dog colonies, and by overlaying the image with snake home range polygons, see the degree of overlap between snakes of both sexes. In addition, the Center was able to provide information to concerned groups as to where snakes traveled and suggest ways that people might dissuade snakes from entering their property. Naturalists at the Plains Conservation Center have used the image when speaking to school groups and visitors about prairie conservation and the role of rattlesnakes in the natural environment. We hope to see this research published in a journal soon.

You will be pleased to know that the Foundation has supported other Colorado-based requests including: the Mountain Studies Institute which requested of the San Juan Mountains in Southwest Colorado to research the impact of airborne mercury contamination in high elevation ecosystems; the University of Denver request for the Luang Prabang World Heritage Site preservation in Lao, and the Denver Metropolitan State University which requested imagery to study the impact of pine beetle infestation in and around a few Colorado ski areas.

Additionally, GeoEye does business with Colorado entities through reseller or partnership agreements with other companies. For example, last year, the City of Fort Collins purchased GeoEye imagery though one of our partners, Walsh Environmental Scientists & Engineers, to analyze prairie dog habitats and the impact on the local community.

Finally, GeoEye was glad to support to the Boulder County Sheriff's Office when it called requesting assistance in a missing person's case last fall. We acted quickly and turned over several images of the areas in question from our archives. The incident was resolved, the person found alive, and we were happy to assist.

How commercial remote sensing data supports homeland security and national security?

GeoEye supports our warfighters, intelligence community, and first responders 24 hours a day seven days a week. Our constellation of satellites helps to create a more robust National constellation, providing for revisit, assured access, redundancy and surge. Our satellites provide unclassified imagery and derived products that are easily used and shared by warfighters and allied/coalition partners. The GeoEye systems architecture supports direct down-link and tasking—with access to imagery in minutes. GeoEye provides the National Geospatial Intelligence Agency (NGA) imagery through the "NEXTVIEW" contract. It is also through this contract that NGA provided 50 percent funding for our satellite, **GeoEye-1,** which we will be launching later this summer.

The commercial remote sensing industry provides real value to the U.S. taxpayers because the government only pays for the capacity it needs. At the same time, the government benefits from access, revisit, and redundancy of the entire constellation. Our private financing enables more satellites and capabilities for the same tax dollars because the commercial segment absorbs percentage of the costs. GeoEye provides the government with a low financial risk because we bear the risk and the government only pays for data that is delivered. In order to serve our intelligence community, GeoEye has a secure facility in St. Louis, Missouri that provides provide high-quality image processing services based on the world's most advanced digital processing techniques. With more than two decades of image-processing experience, our remote sensing professionals develop, provide and deliver both radiometric and geometric image processing services. We process images from a variety of data sources including our own IKONOS and OrbView-2, as well as and high-altitude and low-altitude aerial imaging systems, Quickbird, Landsat, SPOT and IRS satellite imagery. Our processing services include radiometric balancing, geopositioning, digital elevation data production, orthorectification and mosaicking, and land-use and land-cover classification.

During Hurricane Katrina, we ceased taking imagery for our commercial customers to focus solely on the devastation in New Orleans and the Gulf area. We were moving so much imagery that our usual connection to NGA was stretched to capacity. The Department of Homeland Security (DHS) asked us to set up a separate down-link just for them, which we did immediately. Through this communications pipe, we sent DHS our entire collection of imagery of these areas. This imagery was shared with Federal Emergency Management Agency (FEMA), the military and National Guard, State and local officials. Because our imagery is unclassified, it was shared immediately as soon as it downloaded from the satellite.

What are the main impediments to more effective use of commercial remote sensing data for public sector applications? Our recommendations?

Commercial remote sensing data is making serious gains beyond the traditional national security requirements and other users. With the global Internet-use explosion, interest in Yahoo Maps, Google Earth, and Microsoft Virtual Earth has also skyrocketed. No longer must one be an imagery analyst to appreciate the multiple uses of commercial imager. One could say that the Internet has turned million of consumers into novice imagery analysts. I would also like to remind the Subcommittee that the imagery we sell to the on-line search engines are from our archives, and not new imagery.

Ours is a unique industry. Only we can claim that our satellites have a short time to market (typically only three years), when coupled with low risk acquisition approach that locks down design requirements and does not permit engineering change proposals (such as non-reoccurring engineering costs)—these **factors contribute to holding costs down while providing value to the government and the taxpayers.**

We believe that it is imperative that the U.S. Government allows the American commercial remote sensing industry to continue to be the best in the world. Foreign competition is nipping at our heels. It is critical that the government removes the handcuffs so we can continue to lead, not follow, the commercial remote sensing industry. A review of the current resolution policy of .51 meters would be an excellent starting point.

As you may know, **GeoEye-1** will collect at .41 meters, but because of U.S. policy, we must decrease the resolution and sell it to our international and commercial partners at .50 meters. Meanwhile, other countries are moving quickly ahead to build next-generation capability that will eventually best this figure. In order for our industry to continue what we do best—provide fast, unclassified down-links, we need to continue to be on the cutting edge of technology, and not on the sidelines.

Our industry is unique in that we sell almost 50 percent of our data in the commercial marketplace, and it is this sector that is growing and steadily demanding concessions that the national security community may not like. However, the main objective behind the President's policy has always been to strike a balance between commercial considerations and national security requirements.

The U.S. Government does not need to "help" us per se, but it should not hold us back when foreign governments are actively helping its' own home-grown companies to launch smaller, better resolution satellites. Essentially, the competitive landscape has changed enough that the U.S. Government is not protecting anything new by holding us back because foreign competitors are actively engaged in besting our technologies. Mr. Chairman, America's greatness should not be constrained by our own government.

CONCLUSION:

Mr. Chairman and Ranking Member Feeney, thank you for your leadership and commitment on this very important issue. As you know, the future is already here. The demand for commercial imagery will only increase with growing government requirements and by commercial demands—to include environmental organizations, oil and gas, utility companies, and non-profit institutions. Given the growing consumer appetite for commercial imagery, we believe we are in a unique position to support both national requirements and to satisfy international and commercial needs. **In essence, if we are given the opportunity to participate—our industry will not only fulfill many of the U.S. Government's requirements, but also sustain the industrial base by providing American jobs. This includes the industrial base of satellite manufacturers and ground infrastructure, the second tier subcontractors to the primes, and the geospatial intelligence community. Our imagery enables multiple applications and they, in turn, spawn new businesses. These are high-tech, highly-skilled, and good paying jobs. The Department of Labor recently highlighted geospatial technologies as one of the top three fastest growing and most important high growth industries in the 21st Century (the others were nanotechnology and biotechnology.) This is clearly a win-win situation for America and for the American taxpayers.**

ATTACHMENT A

U.S. Space Policy Excerpts

- U.S. Commercial Remote Sensing Policy (2003)
- Rely to the maximum practical extent on U.S. commercial remote sensing space capabilities for filling imagery and geospatial needs for military, intelligence, foreign policy, homeland security, and civil users;
- Develop a long-term, sustainable relationship between the United States Government and the U.S. commercial remote sensing space industry;
- Competitively out-source functions to enable the United States Government to rely to the maximum practical extent on commercial remote sensing space capabilities for filling imagery and geospatial needs;

U.S. National Space Policy (2006)

- The United States is committed to encouraging and facilitating a growing a entrepreneurial U.S. commercial space sector. Toward that end, the United States Government will use commercial space capabilities to the maximum practical extent, consistent with national security.
- Enable a dynamic, globally competitive domestic commercial space sector in order to promote innovation, strengthen U.S. leadership, and protect national, homeland, and economic security.
- Refrain from conducting activities that preclude, deter, or compete with U.S. commercial space activities, unless required by national security or public safety.

Opening Statement of Matthew O'Connell President and CEO GeoEye Inc.

Presented to the House Committee on Science & Technology – Subcommittee on Space and Aeronautics

April 7, 2008

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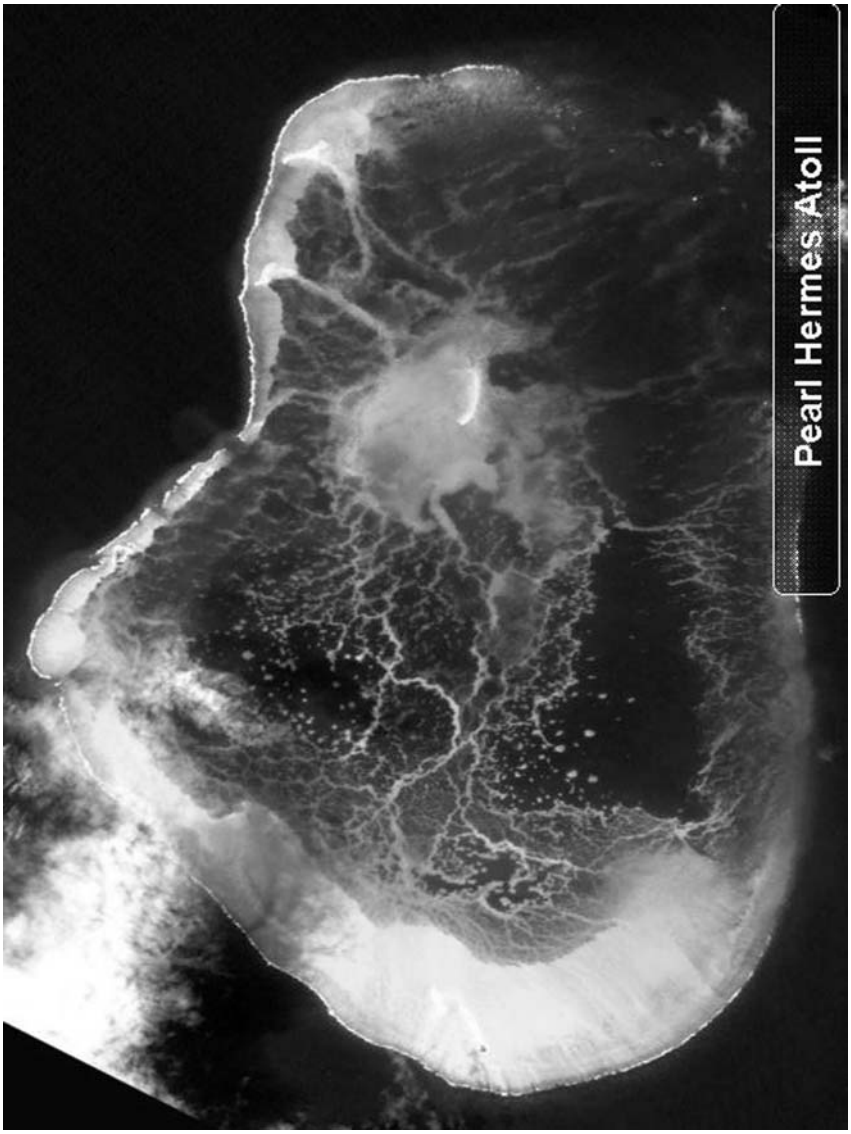
Big Bear Glacier, Alaska


Beijing Olympic Venues, China


Pearl Hermes Atoll

America Under Attack:
Defining Moments for the Commercial Imagery Industry

World Trade Center Site – Before and After

GeoEye

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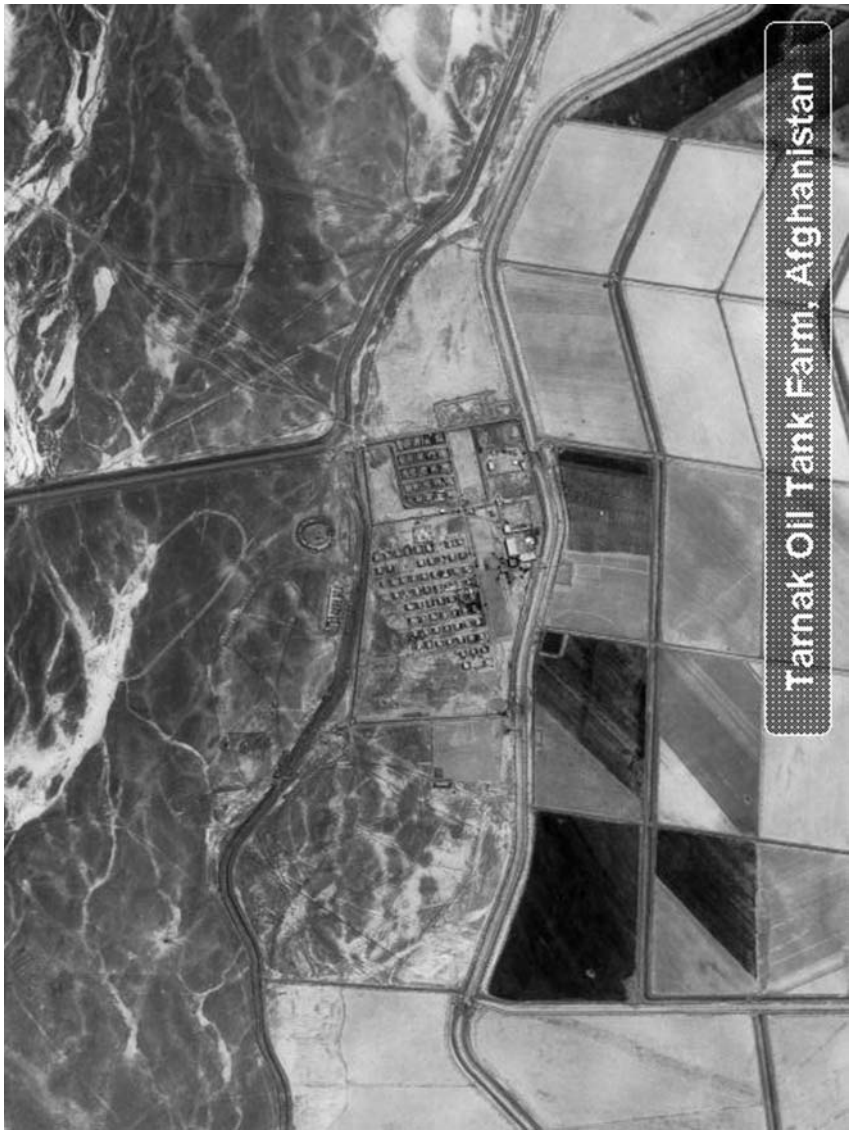
Tarnak Oil Tank Farm, Afghanistan

Minneapolis, Minnesota
I-35W Bridge Collapse

GeoEye

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Hurricane Katrina

Gulfport, Mississippi

GeoEye

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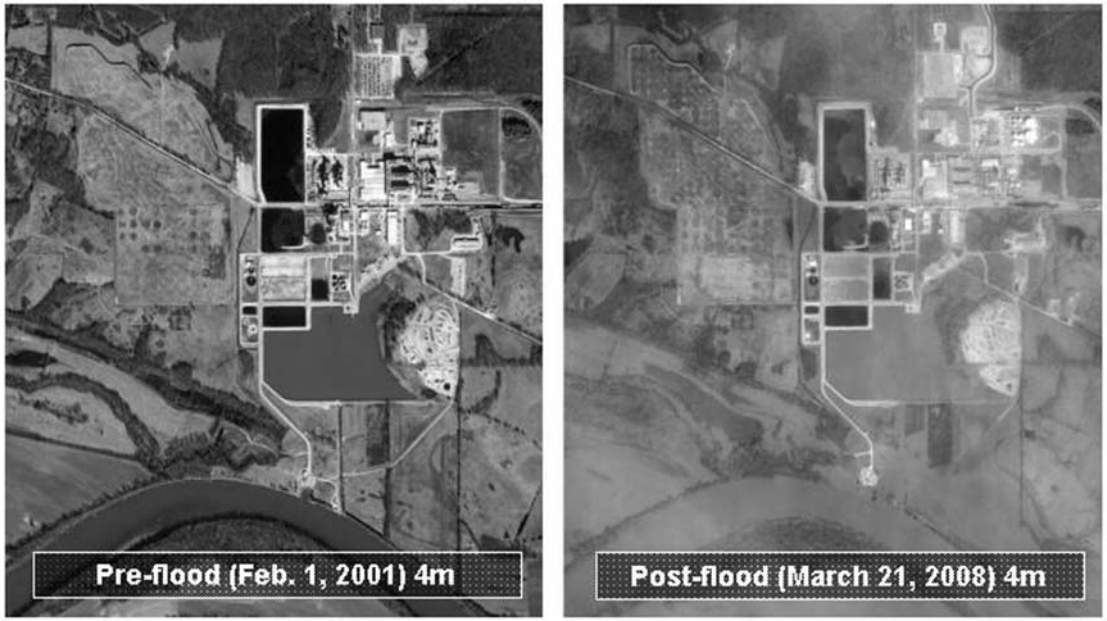
Newark Power Plant, Rosie, Arkansas



GeoEye

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Value Added Homeland Security Applications

GeoEye

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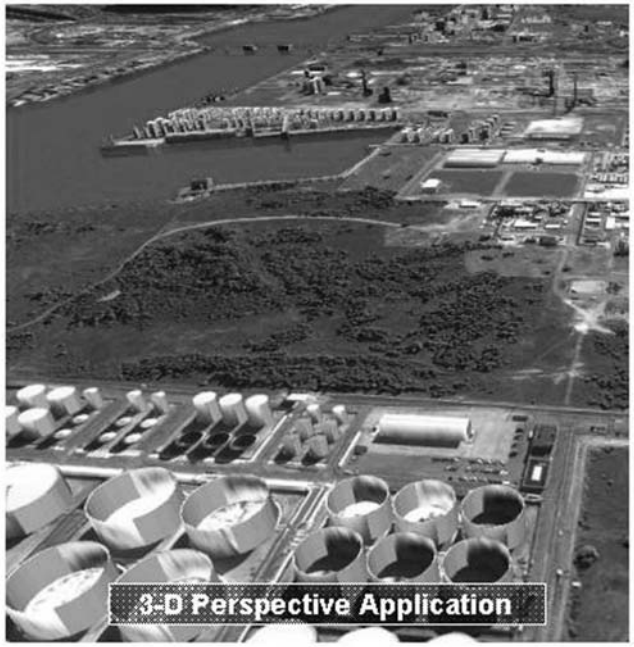
Marine and Port Protection

GeoEye Advantages

- Excellently situated to support infrastructure mapping and monitoring of:
  - Airports & Marine ports
  - Oil and Gas Pipelines
  - Highways



GeoEye

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Tsunami Post-Disaster Assessment

Blue Village Pankarang Resort, Khao Lak, Thailand

GeoEye

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Environmental Monitoring

Santa Clarita, CA Wildfires

GeoEye

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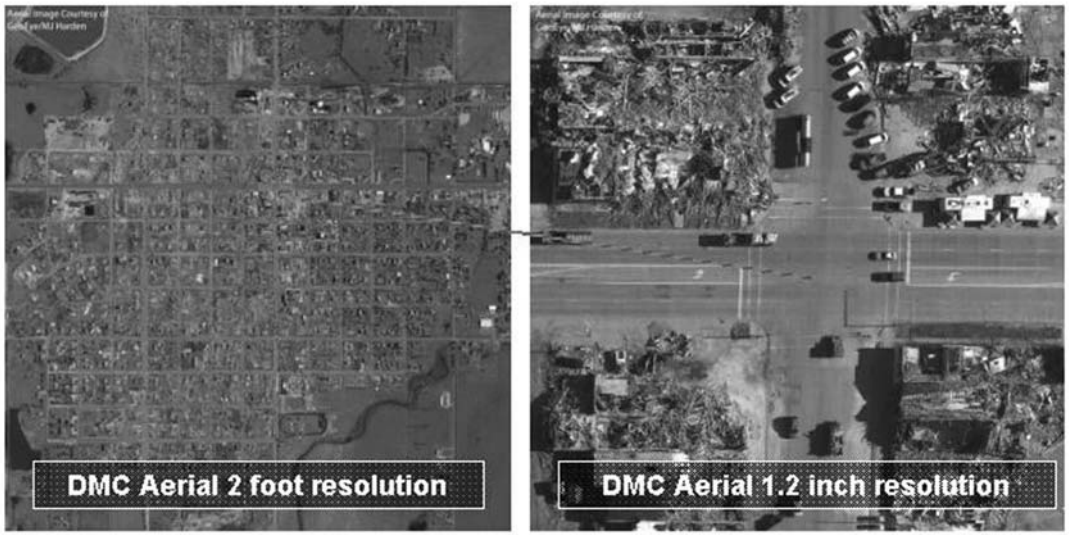
Greensburg Kansas - Tornado Damage
Collected May 12, 2007



GeoEye

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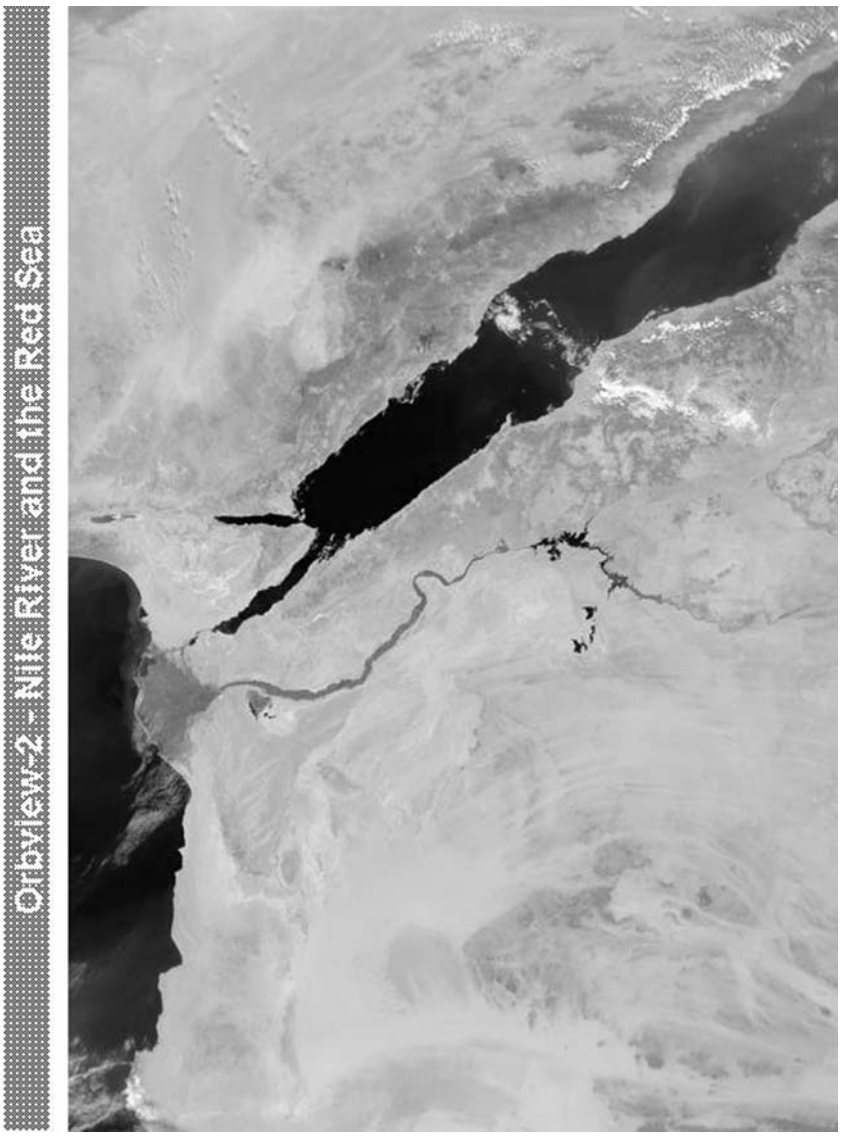
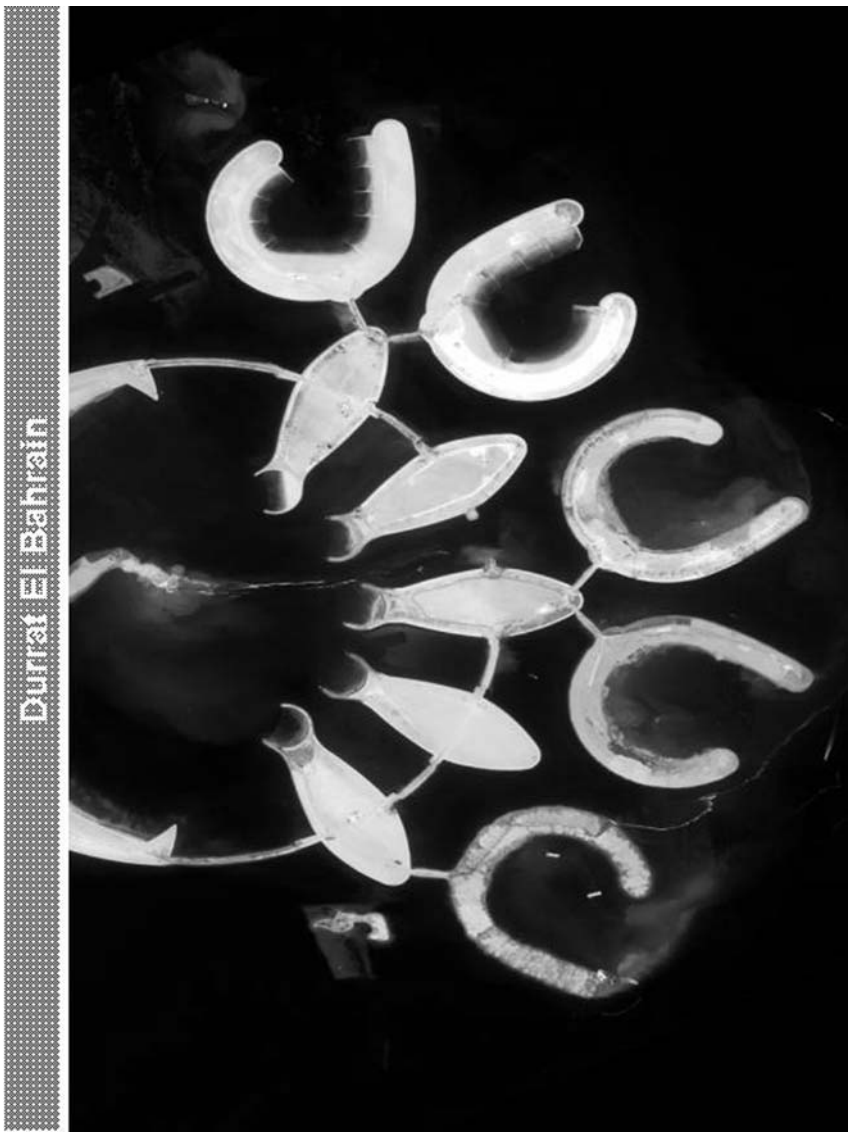
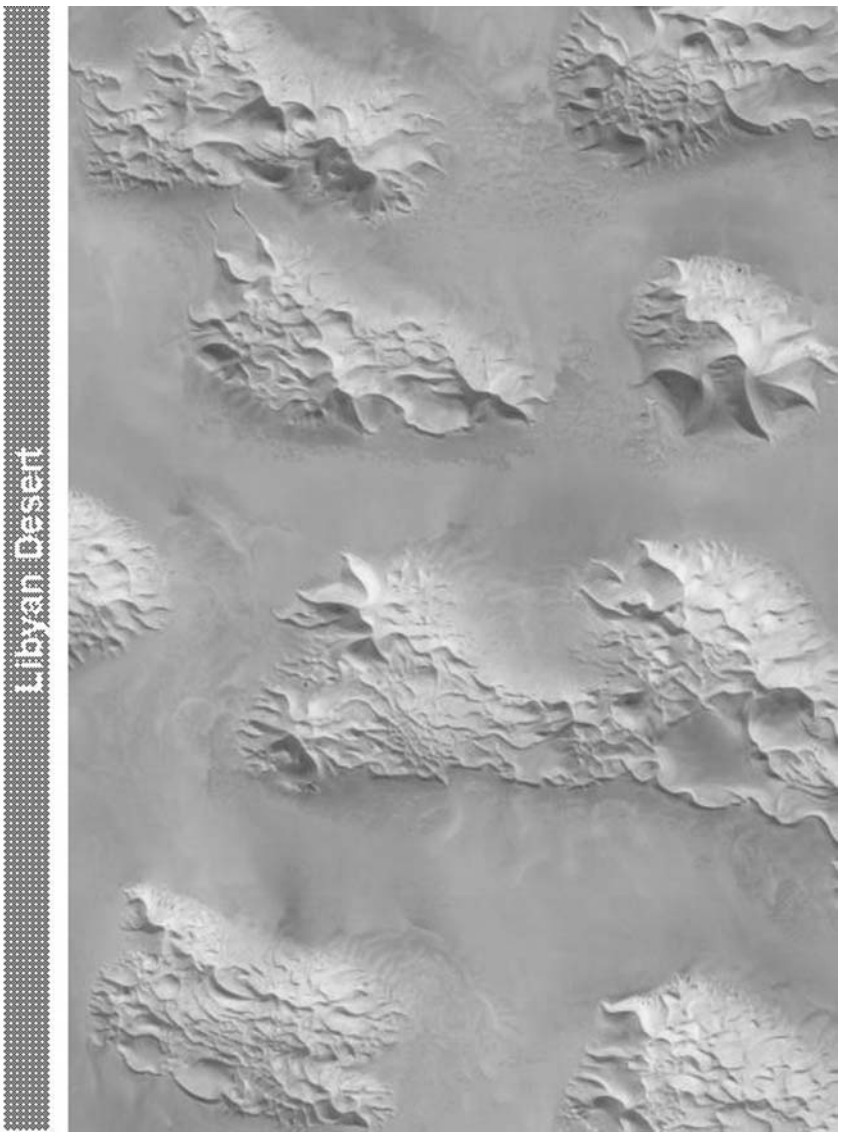
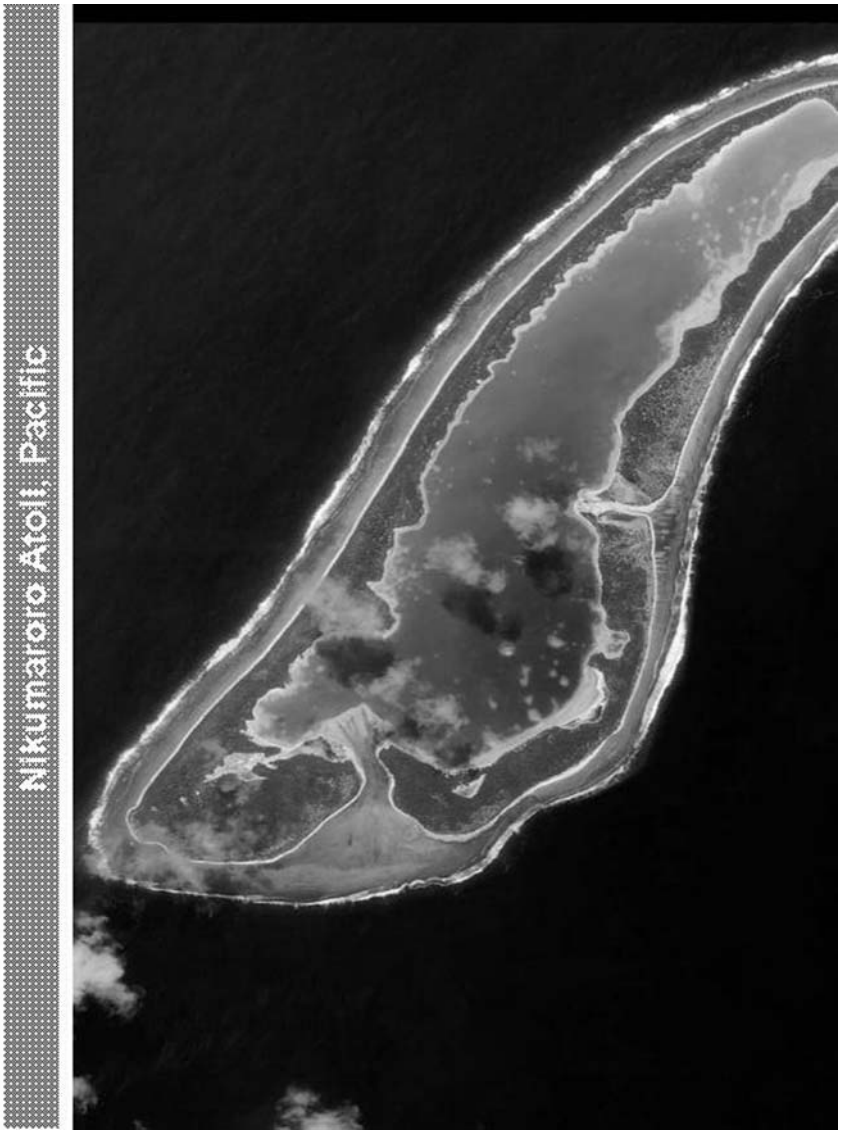


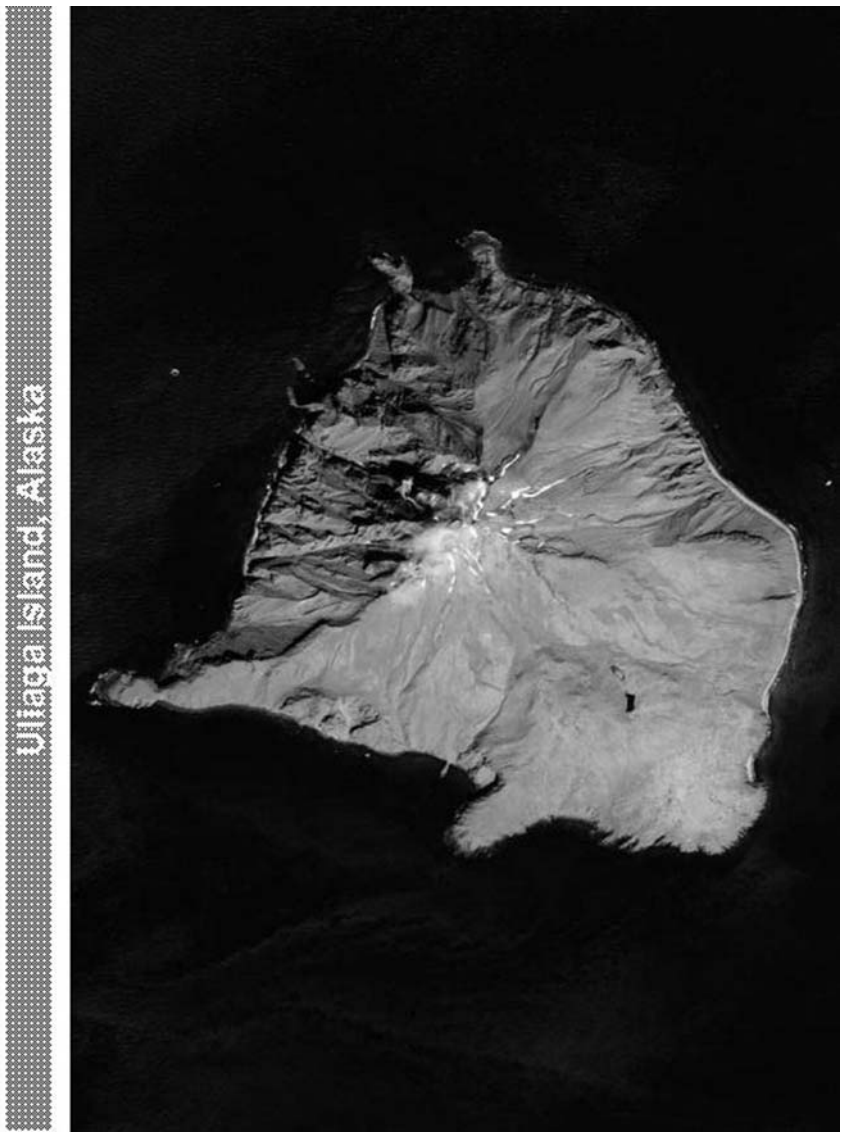
OrbView-2 – Nile River and the Red Sea


Burial El Bahrain


Ulayan Desert



Nikumaroro Atoll, Pacific



Ulaga Island, Alaska


"Burning Man" Nevada

BIOGRAPHY FOR MATTHEW M. O'CONNELL

Mr. O'Connell is GeoEye's President and CEO. GeoEye, headquartered in Dulles, Virginia, is a leading provider of satellite and aerial imagery and geospatial information. The company, with 400 employees, operates two Earth-imaging satellites, IKONOS and OrbView-2, two mapping aircraft, possesses an international network of regional satellite receiving ground stations and has advanced geospatial imagery processing capabilities. Key customers include the Department of Defense and intelligence community, strategic business partners, U.S. and international resellers and commercial customers. GeoEye is traded on the Nasdaq exchange (GEOY) and is listed on the Russell 3000 index. GeoEye is launching its next generation satellite, GeoEye-1, later this year. GeoEye-1 will be the world's highest resolution and most accurate commercial Earth-imaging satellite, with a ground resolution of 0.41 meters or about 16 inches.

Mr. O'Connell has over twenty years of experience in communications management and finance. He came to the commercial remote sensing industry in 2001 as CEO of GeoEye's predecessor, ORBIMAGE. In January 2006, Orbimage merged with Space Imaging to form GeoEye, Inc. In January 2008, O'Connell was appointed by the Department of the Interior to serve on its National Geospatial Advisory Committee. In February 2008, O'Connell was elected to the U.S. Geospatial Intelligence Foundation's (USGIF) Board of Directors and in October 2007 was presented with their Industry Leader award. Also in October 2007, Deloitte named GeoEye as one of the Fast 50 companies in the Washington D.C. area, ranking the company number twelve. In June 2007, Mr. O'Connell was named "Entrepreneur of the Year" by Ernst and Young for Communications in the Washington D.C. region. The *Washington Post* ranked GeoEye number one of all companies in the D.C. area for 2006 revenue growth. Additionally, *Space News* named O'Connell one of the *"10 Who Made a Difference in Space in 2006"* and *Via Satellite Magazine* named O'Connell as *"One to Watch in 2008."*

Prior to joining GeoEye, Mr. O'Connell was a Managing Director at Crest Advisors, a New York-based private merchant bank that invested in and advised communications companies, and Senior Vice President of Legal and Business Affairs for Sony Worldwide Networks, a division of Sony Corporation specializing in radio and Internet programming. Before working at Sony, he served as Senior Vice President and general counsel of Osborn Communications Corporation, a publicly traded radio and television station operator. Prior to his tenure at Osborn, Mr. O'Connell was the assistant general counsel at Cablevision Systems Corporation, where he was responsible for acquisitions and finance, including the company's initial public offering. Mr. O'Connell began his career on Wall Street as a lawyer specializing in mergers and acquisitions and corporate finance. Mr. O'Connell holds a Bachelor of Arts degree in Classics from Trinity College, where he was elected to Phi Beta Kappa, and a Juris Doctor from the University of Virginia Law School.

Chairman UDALL. Ms. Smith.

STATEMENT OF MS. JILL SMITH, PRESIDENT AND CHIEF EXECUTIVE OFFICER, DIGITALGLOBE, INC.

Ms. SMITH. Thank you. Mr. Chairman and Members of the Subcommittee, thank you for giving me opportunity to appear before you today on behalf of DigitalGlobe to discuss the applications and benefits of remote sensing data.

DigitalGlobe was founded on the principal that remote sensing data, specifically that acquired through satellite and aerial imaging capabilities, can change the way organizations conduct business and how governments protect their constituencies. Today more than ever, we at DigitalGlobe are seeing some of the unique ways businesses are improving their efficiency and streamlining business processes. We are also seeing increasing use by governments on emergency response planning, urban development, and environmental monitoring.

DigitalGlobe's customers range from defense and intelligence entities to civil agencies supporting land development and emergency

response to companies providing consumer applications, including personal navigation services, and Internet portal tools.

There are several advantages as a company being headquartered here in Colorado, from the synergies that are created by having the second largest aerospace industry in the Nation, to enjoying the benefit of having a robust GIS and remote sensing industry located here, and also the ability to partner with several of the country's leading, excuse me, academic institutions to develop relevant technical talent and also a fabulous lifestyle that allows us to attract the best people.

State and local government agencies, including those in Colorado, use remote sensing data to meet the requirements of many essential public service projects. Towns, cities and counties rely on remote sensing data to understand the makeup of their areas for tax assessments, public works and public safety applications. In Colorado, in particular, as we've heard today, it's particularly valuable for agricultural monitoring, wildfire risk assessment, and watershed mapping.

At the same time, users at the national level utilize remotely sensed data for a variety of purposes. Specifically, certain U.S. Government defense and intelligence agencies supply their users with unclassified, commercial data for homeland security, national defense and intelligence programs. Availability of commercial satellite imagery has provided the government with flexibility in how it gathers intelligence, conducts surveillance, and manages ground, air and naval forces. Because commercial imagery is unclassified, it can be shared across organizations and agencies, across domestic users and with allies, coalition forces and humanitarian aid workers to facilitate coordination.

Remote sensing data can help to speed decision-making for military planning and in-theater activities and for emergency response activities. The remote sensing data provided by satellite imagery provides the capability to conduct detailed reconnaissance and subsequent extraction of critical information on targets.

In addition to military uses, remote sensing data can be very valuable to civilian homeland defense efforts, including mapping potential fire, flood, hurricane or earthquake paths; monitoring the expansive U.S. borders both land and sea; and identifying possible breaches of secure and protected high-risk facilities such as nuclear plants and seaports.

One of the key enablers of the broader use of commercial remote sensing data has been the continued support of the U.S. Government. In 1992 *Land Remote Sensing Policy Act* set a baseline for the licensing and operation of commercial remote sensing space systems and is still in effect today. And more recently, in the Commercial Remote Sensing Policy of 2003 and the 2006 U.S. National Space Policy have the stated objective of creating a "dynamic, globally competitive domestic commercial space sector in order to promote innovation, strengthen U.S. leadership, and protect national, homeland and economic security."

We believe the policies encourage the U.S. Government to: (A) rely to the "maximum practical extent" on U.S. commercial capabilities, (b) "refrain from conducting activities that preclude, deter, or compete with U.S. commercial space activities," (c) "develop a

long-term, sustainable relationship" between the U.S. Government and U.S. industry, and (d) provide a "timely and responsive regulatory environment" for licensing the operation and export of remote sensing systems.

Congress has been a consistent and vocal supporter of U.S. defense and intelligence use of commercial remote sensing data through the ClearView and NextView programs. These programs have helped the U.S. Government provide an increasing amount of commercial imagery to the warfighter, intelligence analysts and relief workers every day. The industry looks forward to continuing to work with Congress to ensure continuity of programs such as these well into the future.

While we believe there is widespread Congressional and Executive branch support for the growth of the commercial remote sensing industry, many obstacles nevertheless exist. U.S. Government advocates must remain vigilant that the enabling tenants laid out in the 1992 Act, and the 2003 and 2006 policies continue to have support. We believe the benefits of commercially available remote sensing data are significant and that the industry is only just beginning to develop applications.

So on behalf of DigitalGlobe, I would like to thank the Congress, especially this subcommittee and Congressman Udall, Senior Ranking Member Feeney, for your support from the earliest days of the industry into the future. That concludes my testimony. I would be happy to answer questions. Thank you.

[The prepared statement of Ms. Smith follows:]

PREPARED STATEMENT OF JILL SMITH

Mr. Chairman, and Members of the Subcommittee, thank you for giving me the opportunity to appear before you today on behalf of DigitalGlobe to discuss the applications and benefits of remote sensing data.

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DigitalGlobe's customers range from defense and intelligence entities to civil agencies supporting land development and emergency response to companies providing consumer applications, including personal navigation services, and Internet portal tools.

There are several advantages of being headquartered here in Colorado, from the synergies that are created by having the second largest aerospace industry in the Nation, to enjoying the benefit of having a robust GIS and remote sensing industry located here. Another important advantage is the ability to partner with several of the country's best academic institutions for developing relevant technological talent and the lifestyle that allows us to attract the best people.

State and local government agencies, including those in Colorado, use remote sensing data to meet the requirements of many essential public service projects. Towns, cities and counties rely on remote sensing data to understand the makeup of their areas for tax assessment, public works and public safety applications. In Colorado, it is particularly valuable for agricultural monitoring, wildfire risk assessment, and watershed mapping.

At the same time, users at the national level utilize remotely sensed data for a variety of purposes. Specifically, certain U.S. Government defense and intelligence agencies supply their users with unclassified, commercial data for homeland security, national defense and intelligence programs. Availability of commercial satellite imagery has provided the government with flexibility in how it gathers intelligence, conducts surveillance, and manages ground, air and naval forces. Because commercial imagery is unclassified, it can be shared across organizations and agencies,

across domestic users and with allies, coalition forces and humanitarian aid workers to facilitate coordination. Remote sensing data can help to speed decision-making for military planning and in-theater activities and for emergency response activities. The remote sensing data provided by satellite imagery provides the capability to conduct detailed reconnaissance and subsequent extraction of critical information on targets.

In addition to the military uses, remote sensing data can be very valuable to civilian homeland defense efforts, including mapping potential fire, flood, hurricane or earthquake paths; monitoring the expansive U.S. borders both land and sea; and identifying possible breaches of secure and protected high-risk facilities such as nuclear plants and seaports.

One of the key enablers of the broader use of commercial remote sensing data has been the continued support of the U.S. Government. The 1992 *Land Remote Sensing Policy Act* set a baseline for the licensing and operation of commercial remote sensing space systems and is still in effect today. And more recently, the Commercial Remote Sensing Policy of 2003 and the 2006 U.S. National Space Policy have the stated objective of creating a "dynamic, globally competitive domestic commercial space sector in order to promote innovation, strengthen U.S. leadership, and protect national, homeland and economic security."[1] We believe the policies encourage the U.S. Government to: (a) rely to the "maximum practical extent"[2] on U.S. commercial capabilities, (b) "refrain from conducting activities that preclude, deter, or compete with U.S. commercial space activities,"[3] (c) "develop a long-term, sustainable relationship"[4] between the U.S. Government and U.S. industry, and (d) provide a "timely and responsive regulatory environment"[5] for licensing the operation and export of remote sensing systems.

Congress has been a consistent and vocal supporter of U.S. defense and intelligence use of commercial remote sensing data through the ClearView and NextView programs. These programs have helped the U.S. Government provide an increasing amount of commercial imagery to the warfighter, intelligence analyst and relief worker every day. The industry looks forward to continuing to work with Congress to ensure continuity of programs such as these well into the future.

While we believe there is widespread Congressional and Executive branch support for the growth of the commercial remote sensing industry, many obstacles nevertheless exist. U.S. Government advocates must remain vigilant that the enabling tenets laid out in the 1992 Act, and the 2003 and 2006 policies continue to have support. In particular, it is important that the U.S. Government continue to maximize its use of commercial imagery, ensure a regulatory environment that promotes the commercial imagery business, and enable U.S. industry to continue to be competitive in the global imagery market.

We believe the benefits of commercially available remote sensing data are significant and that the industry is only beginning to develop potential applications.

On behalf of DigitalGlobe, I would like to thank the Congress, especially this subcommittee and Congressman Udall, for your support from the earliest days of the industry into the future. That concludes my testimony. I will be happy to answer any questions you may have.

BIOGRAPHY FOR JILL SMITH

Jill is a veteran corporate leader with a long history of strategic management and successful brand building. She was President and Chief Executive Officer of eDial, a collaboration software company that she successfully turned around and sold to Alcatel. Prior to leading eDial, she was Chief Operating Officer of Micron Electronics, Inc., a $1.5 billion direct PC manufacturer and marketer. While at Micron, Jill drove the PC business to profitability, and grew HostPro, Micron's award-winning web hosting division, into the third-largest web and application hosting company, and a candidate for an IPO. Prior to Micron, Jill co-founded and led Treacy & Company, LLC, a successful boutique consulting and investment business that was merged with an Internet consulting firm, and was Chief Executive Officer of SRDS, L.P., a private publishing and printing company that she successfully repositioned and established as an electronic publishing leader. Her earlier experience includes executive positions at Sara Lee Corporation and Bain & Company, where she

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[1] *U.S. National Space Policy* (2006)
[2] *U.S. Commercial Remote Sensing Policy* (2003); *U.S. National Space Policy* (2006)
[3] *U.S. National Space Policy* (2006)
[4] *U.S. Commercial Remote Sensing Policy* (2003)
[5] *U.S. Commercial Remote Sensing Policy* (2003); *U.S. National Space Policy* (2006)

was a Vice President. Jill holds a Master's Degree in Business Administration from the MIT Sloan School of Management.

DISCUSSION

Chairman UDALL. Thank you, Ms. Smith, and thank you to a very important group of witnesses. I'm going to move right to questions, and recognize myself for five minutes, and I would like to ask each of you in turn. I'll start with Mr. Little, and I'll remember later on I'll start with Ms. Smith on the next question, in the spirit of Mr. Byers who was on the previous panel.

The benefits of commercial over federal data, this is an important discussion. What opportunities do commercial remote sensing data enable over remote sensing data available from federal and other public sources? And as a follow-on, could you please describe the applications that the commercial remote sensing data can support?

Mr. LITTLE. Absolutely. Thank you for the question. It's quite valid. As one of my colleagues indicated earlier, the advantage of having commercial remote sensing data to the community, with coalition partners, et cetera, it's unclassified, typically accessible via the Internet, lots of commercial applications to support that. We ask that commercial be looked at a little more strongly.

The NGA and DOD has done an excellent job of looking at the outside community, if you will, at the commercial side, to do the—take care of some of these technologies.

Chairman UDALL. Mr. O'Connell.

Mr. O'CONNELL. As Kevin—it is a great question, sir, as Kevin said. The fact that we're unclassified is a terrific advantage, as we learned with Hurricane Katrina. The government can't disseminate it's classified images quickly. In Katrina, I know that both Jill and I devoted a lot of our taskings to New Orleans. And as soon as the imagery was available, it became publically disseminated. In fact we had a lot of discussion with the NGA at the time. They did a very good job of saying, how do we get this public? Dump it on all of the different providers, not just Google, not just Microsoft, so a relief worker could immediately find out what was going on.

Similarly, we refer to them in articles such as Space News, that overseas our warfighters find unclassified imagery terrific because they can turn to an English person, and you see a tank. They can't do that as easily with classified imagery. So the fact that we're unclassified really helps.

Another thing that helps terrifically is our private financing helps relieve the government of financing expensive satellites. Jill and I both benefited to the tune of about $500 million. I would say the government benefited even more. We go out and borrow privately, and provide much of, if not most of the operating and investment capital. So I think that we provide great services, great price. The fact that it's unclassified means that it gets out faster to the people who need it.

Ms. SMITH. Thank you. Reinforcing what's already been said in terms of unclassified. Second of all, as Mr. O'Connell highlighted, the proven economics of the commercial remote sensing providers, in terms of their ability to manage large contracts and deliver on time and on budget.

Thirdly is, of course, supporting the U.S. industry in terms of space technologies, and reinforcing and perpetuating a leadership in the world that the U.S. is established, aided and abetted by the policies that have been adopted.

And so those things in combination should ensure that the benefits to the user are evident in terms of the applications we've heard about. The economics of the taxpayer are evident in terms of the delivery that the commercial remote sensing providers have been able to secure, and should ensure that there is continued leadership on the part of the U.S. globally in terms of technologies for the source.

Chairman UDALL. I would like to come back to that leadership role you play in the next round. Congressman Feeney has five minutes, and then we'll come back to the second round of questions.

Mr. FEENEY. Well, thank you to all of our witnesses. Mr. O'Connell, you talked a little bit about foreign competition. Can you describe the capabilities some of the foreign competition has, which countries, which private sector activity or government activity, and what forms of relief do you think we need to help our American companies with as we face the potential for more foreign competition.

Mr. O'CONNELL. Congressman Feeney, thank you for asking the question.

Mr. FEENEY. You're welcome.

Mr. O'CONNELL. The French—in short, I'll just say France, Israel, Korea, Taiwan, India, Russia all have domestic programs. None of them are truly commercial, so we're competing with our hands tied behind our back with people. France has .7 meters coming on stream. They're currently using the spider model Kevin showed you earlier. It's five meters that they artificially turn into 2.5 meters.

India has one meter. It's wildly inaccurate. Our satellites are both highly accurate. I know that ours is true within three meters. The Indian satellite, although it has one meter imagery, can be inaccurate by 225 meters. So it's not terribly good for that. The Israelis have imagery which is pretty and .7 meters resolution. It's not accurate.

The Koreans have imagery that's one meter, and although the accuracy is not good, they're working on improving it. The Taiwanese have roughly one meter accuracy. Their satellite is unusual because it always follows the same ground tracks. However, all of these nations are trying to compete with us.

I would say, sir, that we don't need relief. I think that the partnership we have is a true partnership. We believe that we deliver good imagery to our warfighters, to FEMA. We're not looking for a subsidy. If the government continues to buy from us at what we believe are highly advantageous rates, then the government will not only get the imagery and solutions it needs, it will keep the foreign competitors at bay. It will continue to have America be the leaders. And as I think all three of us have said, it's much better for the foreign countries to come here and buy imagery from us than for us to have to go buy our imagery from foreign countries.

Mr. FEENEY. Well, you mentioned, for example, Taiwan in that list. Surely Taiwan has the capabilities the Chinese do. They're just

not using it for commercial purposes. Their entire space program is under the Defense Department, and it's very opaque or secretive.

Mr. O'CONNELL. Yes, the Chinese have the formidable capability. They're not as highly advanced. America is still the best in the world, Jill and I both do a lot of good imagery. The foreigners are definitely trying to catch up.

I would say that the French are highly competitive. The mainland Chinese have the most aggressive program in terms of volume in satellites. Of course, we're unsure about exact details, but they have a very different attitude. If they tried and failed, they'll try 10 more times.

Mr. FEENEY. Ms. Smith, anything to add about the foreign competition.

Ms. SMITH. No. I think Mr. O'Connell highlighted the essence of that competition, except to say that as we think about the future of this industry, in some ways the emphasis is getting away from, as it were, simply vernacular. We use the raw pixels, and to provide better solutions as we heard this morning about new ways to disseminate data. It's no longer just having the data; it's what you can then do with the pixels to then provide value to applications.

And so the emphasis of the U.S. industry to increasingly focus on superior applications, and around utility, including dissemination, is an essential part of our defensive response and offensive response to foreign competition.

Mr. FEENEY. You heard earlier—this is for all of the witnesses. Just briefly, you heard the earlier panel talk about problems that could be created for them if Landsat 5 or 7 went down and we had a gap. Would it create specific problems for what you do in terms of your capabilities.

Mr. O'CONNELL. It would create problems for some of the people that we consider clients. But we have a satellite called OrbView-2 that delivers ocean information that's used by researchers around the world. I know that would be a significant issue for them.

We're actually developing a deeper relationship with those people because we created a foundation to the scientific community to develop new applications. Similar to the extent they suffer, we suffer. You'll be happy to hear that the University of Florida and lots of schools in Colorado are using that imagery. We wanted to develop innovative products, as Ms. Smith said. It's very important for America to continue to have the cutting edge. So in the terms of the scientific community, it doesn't hurt us directly, but hurts us indirectly.

Mr. FEENEY. I may have a question or two on the second round. Mr. Chairman.

Chairman UDALL. Let's move to the second round, I'll recognize myself again for five minutes. I want to peer at this discussion, drill down a bit further on what Congressman Feeney brought up. What's the most important factor enabling your company to compete and agree in the global remote sensing industry? And as a follow-on, what role does the government play in promoting a healthy commercial remote sensing industry.

We covered a little bit of this ground. I want to get this on the record, and opportunities that will—that are present for us. So we'll start with Jill.

Ms. SMITH. I think there are two core areas where the—how Congress plays out and how the U.S. Government manages the industry and materially helps ensure that we, as an industry, are able to retain leadership. The first is around policies and regulations. And I'll come back to that in one second. And second is around advocacy.

And with regard to policy and regulation, the first from our perspective is to ensure vigilance around implementation of the policies that have already been articulated, have already been put in place, are to ensure that we are using commercial imagery and commercial companies to the maximum extent possible for investing and building out U.S. Government assistance.

The second wall is ensuring that the licensing regulations that are governing our industry don't further impede the industry. And where appropriate, and as the markets change, enable us to be as competitive as we can be in the industry while still, of course, protecting national security.

With regard to advocacy, we have, today, in place an office of space commercialization which is currently under NOAA. There is a legislation that has been proposed by the Department of Commerce to reinforce and strengthen the role of the office of space commercialization, and we would agree that this is a very important potential step forward to ensure long-term advocacy.

Mr. O'CONNELL. I'd like to echo what Ms. Smith said. I think that there are existing policies in place right now that are terrific policies. I think that the government has to be vigilant to be sure that they're adhered to. The policy currently states that the U.S. Government should, to the extent possible, use as well as it can for its commercial remote sensing needs.

There are a lot of areas that we can fulfill, as I said before. The collection of broad area mapping is something that we can do, we think, faster, better and cheaper than the U.S. Government, so we would like the government to continue to use us for that, and in fact to look at our other areas where we could do that.

Again, we believe that the taxpayer benefits every time they buy a pixel from us. We also believe that the current regulations have—that have recently been relaxed allow us to distribute imagery at a resolution of .5 meter. That's important. It came a little late because the French actually started distributing—or, I'm sorry, the Israelis were distributing imagery at a lower resolution than Americans were permitted to for a while.

So I think the government has to continue to monitor that. There's no reason why we should be playing. Right now, on our next satellite, we'll image at .41.

We'll be required to raise that imagery up to .5. That doesn't bother us at the moment because nobody's competitive, although it doesn't really make that much sense. I think that it's important that the—it's important that the U.S. stay the leader and not be the follower.

Chairman UDALL. Mr. Little.

Mr. LITTLE. Yes, very quickly I concur with everything they've said. Another thing that just came to mind is the fact that, for instance, this is a daunting task in satisfying the requirements, et cetera. They spend a lot of money doing a lot of things. And my

opinion is that they probably shouldn't be spending that money to, like, remap the U.S. The risk map that FEMA is putting together, and flood plane mapping, et cetera. They're asking the Congress for five years, and that can more readily be done by the commercial entities that are available, and they could spend their efforts and their monies probably a little more wisely. Thank you.

Chairman UDALL. I was saying to Congressman Feeney that he and I are going to look further into the situation you just described because we have limited resources. We have a lot of needs. We don't want to sort of duplicate activities. I know we're going to have a third round. I'm going to end the second round and recognize Mr. Feeney.

Mr. FEENEY. What, Mr. O'Connell, prohibited some of the finer capabilities that you have? Is that for security means? I mean, what—you know, I honestly don't think anything in this environment is secure, but what would be the type of reasoning that government agencies would prohibit you from making available what your capabilities allow you to?

Mr. O'CONNELL. That's a great question, sir. Your own question about privacy, yes, it is related to overall security. There is a lingering sentiment in some parts of the government that there should be no private-sector involvement, and there should be no commercial involvement in overhead surveillance.

As I think Mr. Byers said, the cat is kind of out of the bag on that one. Our question on privacy was a very good one, and I'd like to kind of talk about that, because I think that that's different than what we're talking about here. Mr. Byers said that he believed in transparency. I think we all think it's good being able to see what's going on in Iran. You have to balance that transparency out of our natural desire for privacy. We think the government has done a good job so far. It's tough. We're all subject to follow all those laws and regulations.

Having said that, when terrorists use dual imagery to strike a British camp in Iraq, that was obviously troublesome. When disseminating things to places like Google, that we just adopt a simple rule. Let's not image active military bases in the field. That hasn't been acted on because it's the beginning of a tough question. Then you say, well, how about military headquarters like the Pentagon? How about hospitals? How about schools? People won't stick with simple solutions. So that's never gotten anywhere.

Also, as Mr. Navarro said, it's tough because you have American companies. The government can regulate us. But if the French and Indians and Israelis, and whoever else—the French will sell their imagery. I said it with the French sitting next to me, and they're proud of it. So I don't know how we can constrain an information flow when America doesn't constrain the information.

Chairman UDALL. Ms. Smith.

Ms. SMITH. I have nothing else for that. I think Mr. O'Connell covered it very, very well.

Mr. FEENEY. I guess my last question would be with respect to the data that you rely on from NOAA and NASA, how much do you rely on the data, if at all, from NOAA and NASA, and how free are they in terms of responding to the data requests when you have it? For all the witnesses.

Ms. SMITH. I think it was Mr. O'Connell who referred earlier to fundamentally our job is to provide superior solutions for our customers. And there are, indeed, certain types of applications or simply availability and capacity necessitates that the customer take lower, or I should say, a lower resolution imagery from NASA or NOAA or otherwise.

So we as a company do sometimes put together solutions on integration of multiple sources. And so in that sense, to the extent to which there were any difficulties getting access to that imagery, as Mr. O'Connell said earlier, it would be the customers that suffer. We have had no issues with regard to access to that imagery at all, and likely that it is available to as many users as it is.

Mr. O'CONNELL. We actually do use NASA imagery, and some of our blended products. As Ms. Smith said, it's getting more and more important not just to have pixels, but what do we do with pixels. So we've had to work with the development of complex products. Our efficient product uses our satellite imagery as a base map, and then takes a different resource. That's the terrific part. We sell them imagery. So I can see it has all been great.

I would say on NOAA, on the regulatory side, NOAA has been a very good overseer. They sometimes get, I think—the pace with which the commercial sector operates is daunting, and NOAA has risen to the challenge. I might say, I know it's off the subject, but as long as you're asking, about what Congress may be doing, and that has restricted both of us.

We're not trying to do—we're not trying to put a ground station in China, but we had to send a replacement part to Israel for a ground station that was approved 10 years ago. It took us nine months to get approval. I'm not sure why that works that way.

Mr. LITTLE. Quickly, NOAA, NASA, et cetera, NOAA on the coastal flood areas, NASA on a number of items, we've worked on them globally, as I mentioned earlier on the Merrill Pass in Alaska program. That was an FAA initiative that was funded by NASA, and a very interesting relationship. So they're good folks to work with from our standpoint, very innovative.

NASA's mission is a little different nowadays. As I recall, there was a study done a few years ago that suggested that NASA should probably get out of the Earth observation business and get into the space exploration business where they actually belong, and leave the export of Earth observations to commercial. Thank you.

Mr. FEENEY. Thanks. I don't have any further questions. I'll just say that I sort of instinctively, out of habit, support the commercial side. What I call a phone book test, if more than two people in the private sector provide a good or service, it's probably very unlikely that I would be supportive for the government getting involved. So you've got a sort of instinctive ally.

I want to pass to the Chairman again.

Chairman UDALL. Before I ask this final question, I did want to take just a moment to acknowledge an advantage of a product that each one of your companies provide. Because in part the whole hearing was to further educate the public and trumpet what you all are doing. And I know Intermap has a product, like what we saw on the screen that we use in places like Iraq and Afghanistan as a phenomenal tool.

Mr. O'Connell, I commend to everybody's attention, the second half of your testimony. Some of the best things you're doing in monitoring wildlife and helping us do what we need to do to maintain the populations that not only are important because of our interest in wildlife and the thrill and the inspiration they provide for us, but they help keep our planet healthy.

And then Ms. Smith, DigitalGlobe, some of you may remember, in Boulder County two years ago we were looking for a missing Marine. On immediate request on the weekend, your staff responded, and to the family and to many of us trying to find that Marine. So there's a talent of stories of what you all are doing. It's exciting, cutting edge. The jobs you all provide pay healthy salaries. It's just—it's inspirational. I, like Congressman Feeney, suggest that we default to want to support what you all are doing.

Let me have one final question. Following Dr. Montagu who was on the earlier panel, he urged the Federal Government and the local and regional government to leverage the tremendous purchasing power of the Federal Government in the commercial remote sensing data marketplace.

What's your response to this idea, and are there other things that Federal Government can do? And maybe we'll start with you, Mr. Little, and move back across.

Mr. LITTLE. Very much so. We had a situation with the wildfires in California where NGA and, actually, more Northcom purchased IFSAR data along the coastal areas in California, and inclusive of that. That's part of the whole program. We have, as I mentioned, about 65 percent of the U.S. collected already, very high-resolution terrain.

One of the things that happened out there was a plan to do some C130 drops, water drops. They were trying to do some planning in case there were—they had to evacuate hospitals and nursing homes, those sorts of things. They had to put Marines on the ground, shoes on the ground, boots on the ground, if you will.

In part of the discussion, they also said, what would happen, if we provide this data, gave a license to NGA at this time, under their customers, could we provide to the end-users in California. And we said certainly, as what happened with the tsunami incident in Aceh a few years ago when the satellite guys made their stuff available. We want to encourage that as much as we can. The usage of that is important. So our licensing techniques or methods, we license to the Federal Government. And through that licensing mechanism, it can be licensed ultimately to the end-user.

I think one of the things that came up on the previous panel was it's an education thing as much as anything, because the folks at the end-user level don't understand that it's available or how it's available or how it's licensed. So I hope that answers your question.

Mr. O'CONNELL. As Mr. Little said, we do deliver a lot of imagery at the State and local governments, currently. Our model with NGA is a little different. NGA paid half the cost of the next generation satellite we're building and half the cost of the satellite that was just launched. When you pay that much up front, you get a good discount. That's why the Federal Government would get a fa-

vorable price from us. We would be happy to talk to them about it.

But a part of the next competition was that we had to contemplate we were commercially viable. If you just change it now, it changes some of the revenue streams we were looking at. We're not objecting to it, because we have this really good partnership with NGA. But it's a night and day point where the Department of Labor has said that three of the highest growing areas of jobs are nanotechnology and biotechnology and geospatial sciences.

It's one of the reasons why some—there's been such terrific growth in our offices in Thornton.

We can only hire all those people, in competition with people like Lockheed Martin and ITT who is sitting right here if we are making money. So the revenue mix is complicated. We'd be happy to look at expanding the model and letting the states leverage. I think it's very important that they do use the imagery, but I think that it's a complex issue.

Ms. SMITH. Thank you. Several opportunities have been identified. I'd also like to add the opportunity for better coordination around homeland security. And certainly as an industry, I think we feel as if we are underservicing homeland security because of the challenge of operating both at a local and at a federal level. And therefore we believe there are many opportunities to support that.

Similarly, in terms of ensuring that homeland security acts in a way that is consistent with the commercial remote sensing policy in terms of looking for commercial resources, commercial remote sensing resources, ahead of proprietary U.S. Government resources, therein lies an opportunity to ensure that that's pushed down, not only the federal level, but also into a local level to the benefit of all. Thank you.

Chairman UDALL. Thank you. I did, as I bring the hearing to a close, want to acknowledge the presence of Lockheed Martin, Ball Aerospace, and ITT who have been here as well. And Mr. O'Connell and everybody at the table here knows that they're key links in this whole chain.

I want to thank the two panels of witnesses, citizens of Colorado Springs that have joined us, other interested parties. And to keep faith with Congressman Feeney, as colleagues of mine, if there's no objection, the record will remain open for additional statements of Members and for answers to follow-up questions the Subcommittee may want to ask other witnesses. And without objection, it's so ordered.

The hearing is now adjourned.

[Whereupon, at 12:11 p.m., the Subcommittee was adjourned.]

Appendix:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Submitted to Jack G. Byers, Deputy Director and Deputy State Engineer, Colorado Division of Water Resources

These questions were submitted to the witness, but were not responded to by the time of publication.

Questions submitted by Chairman Mark Udall

Q1. How significant is the issue of training your workforce to use remote sensing information and incorporate it into your organization's services and operations? What role, if any, should the Federal Government play in ensuring that opportunities exist to train workers in the use of remote sensing data and information?

Q2. You testified on the valuable uses of remote sensing data and the benefits your organization has gained in return. What are your suggestions on ways to disseminate or share these applications with other State and local agencies that may be considering the use of remote sensing data or that are unaware of the value it may offer?

ANSWERS TO POST-HEARING QUESTIONS

Responses by A. Simon Montagu, Director, Customer Resource and Support, Denver Regional Council of Governments

Questions submitted by Chairman Mark Udall

Q1. The development of data standards can help facilitate the widespread use of remote sensing data and information. Based on your experience, how well are mechanisms to coordinate the development of data formats and standards among Federal Government agencies and other remote sensing data users such as yourselves working? What, if any, actions should the Federal Government take to strengthen efforts to develop data standards?

A1. My experience with the mechanisms to coordinate the development of data formats and standards is limited to observing the activities of the Federal Geographic Data Committee (FGDC). I have observed the development of various FGDC standards in three different capacities as an educator (teaching GIS at Miami University in Ohio), a data standards "consumer," and as a member of the professional association with direct interest in some of outputs of the FGDC's work.

Generally speaking, the FGDC coordinates these efforts well, allowing for appropriate input and deliberation before publishing the final standards. My only critique would be that some of the resultant standards are overly complex. However, in fairness to the FGDC, this is probably a reflection of the complexity of the subject matter, and the broad scope of the various standards themselves, rather than any inherent flaw in the FGDC process.

Q2. How significant is the issue of training your workforce to use remote sensing information and incorporate it into your organization's services and operations? What role, if any, should the Federal Government play in ensuring that opportunities exist to train workers in the use of remote sensing data and information?

A2. The geospatial technologies industry as a whole remains an important and growing sector of the Colorado economy. This trend is mirrored across the Nation. Sustaining this growth will require a commitment from all levels of government to support the basic skills and knowledge training needed to ensure the industry has the talent it requires.

Fundamental to this is an improved commitment to basic math and analytical literacy. All of the geospatial sciences, but especially remote sensing, require a solid background in the fundamentals of mathematics. My experience teaching in the Geography department at Miami University revealed a wide discrepancy in the level of math preparedness of students coming into college.

For this country to remain a leader in the geospatial technologies industry, our future workforce must receive a basic grounding in math as high school students, rather than play "catchup" in college. The Federal Government's direct role in this is perhaps limited. However, the past history of the aeronautical and engineering sciences suggests that Federal Government leadership and goal setting does do a lot to promote State and local engagement in broader, national endeavors.

Q3. You testified on the valuable uses of remote sensing data and the benefits your organization has gained in return. What are your suggestions on ways to disseminate or share these applications with other State and local agencies that may be considering the use of remote sensing data or that are unaware of the value it may offer?

A3. Fortunately for DRCOG, the community of Regional Planning Commissions/Metropolitan Planning Organizations is relatively small and thus "knowledge transfer" is relatively easy. Indeed, DRCOG learned a great deal from its peers as we put together the Denver Regional Aerial Photography Project.

Additionally, we have as one of our mandates the provision information and tools to our local government membership of matters that are typically outside the purview of their normal governmental operations. This typically includes matters that transcend their jurisdictional boundaries, but also includes matters of new technology of which they may not be aware. We provide this service through a number of avenues, ranging from one-on-one training, informational products distributed both in hard copy and electronic format, and through custom workshops and training courses. We have used all of these formats in recent years to provide DRCOG's member governments with information about current and emerging geospatial technologies with relevancy to the business of local and regional governance.

ANSWERS TO POST-HEARING QUESTIONS

Submitted to Manuel Navarro, Fire Chief, City of Colorado Springs Fire Department

These questions were submitted to the witness, but were not responded to by the time of publication.

Questions submitted by Chairman Mark Udall

Q1. The development of data standards can help facilitate the widespread use of remote sensing data and information. Based on your experience, how well are mechanisms to coordinate the development of data formats and standards among Federal Government agencies and other remote sensing data users such as yourselves working? What, if any, actions should the Federal Government take to strengthen efforts to develop data standards?

Q2. How significant is the issue of training your workforce to use remote sensing information and incorporate it into your organization's services and operations? What role, if any, should the Federal Government play in ensuring that opportunities exist to train workers in the use of remote sensing data and information?

Q3. You testified on the valuable uses of remote sensing data and the benefits your organization has gained in return. What are your suggestions on ways to disseminate or share these applications with other State and local agencies that may be considering the use of remote sensing data or that are unaware of the value it may offer?

ANSWERS TO POST-HEARING QUESTIONS

Responses by Frank J. Sapio, Director, Forest Health Technology Enterprise Team (FHTET), U.S. Department of Agriculture

Questions submitted by Chairman Mark Udall

Q1. How significant is the issue of training your workforce to use remote sensing information and incorporate it into your organization's services and operations? What role, if any, should the Federal Government play in ensuring that opportunities exist to train workers in the use of data and information?

A1. The availability of training opportunities has not been an impediment. Between vendors and internal cadres of technical experts, the agency offers an array of geospatial technology training opportunities for natural resource land managers. The Federal Government should continue to work in partnership with vendors to develop and provide training in the use of data and information collected through the application of remote sensing technologies.

Q2. You testified on the valuable uses of remote sensing data and the benefits your organization has gained in return. What are your suggestions on ways to disseminate or share these applications with other State and local agencies that may be considering the use of remote sensing data or are unaware of the value it may offer?

A2. For the State and Private Forestry Forest Health Protection (FHP) staff, this issue is very relevant. FHP field staff is trained and able to provide technical assistance to State and local partners for use of new technology or technical adaptations. This system works well, though on technology issues, adoption is sometimes slow even with willing State partners. Early stakeholder involvement synergizes the technology adoption process. Involving State partners in the design phase of a project increases the opportunity for the project's successful adaptation and application. A recent example of this type of development is the Southern Pine Beetle Hazard Maps Project, where State partners in 13 southern states had an integral role in project development.

Our Technology Service Centers such as the Remote Sensing Applications Center and the Forest Health Technology Enterprise Team both have robust web sites. Reaching our partners through regular, disciplined, updates of our web site is crucial in keeping our partners aware of the latest developments. Sharing raw and processed data through the multiple agency spatial data clearing houses is also a crucial part of the strategy.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Kevin Little, Director of Business Development, Intermap Technologies, Inc.

Questions submitted by Chairman Mark Udall

Q1. The development of data standards can help facilitate the widespread use of remote sensing data and information. Are you satisfied with the opportunities available to commercial remote sensing companies to help coordinate data formats and standards among Federal Government agencies, academic institutions, and other remote sensing data producers and users? What actions, if any, do you believe would strengthen mechanisms to coordinate the development of data standards?

A1. Overall, the Defense and Intelligence communities within the US government have done an excellent job over the years in evolving and focusing their requirements in out-sourcing their technology needs to the commercial community.

Outsourcing allows these agencies to focus on the complex and dynamic mission requirements that drive their organizations and allow them to remain flexible in partnering with the commercial industry to assist them in satisfying these requirements.

By out-sourcing these requirements, these agencies leverage the funding they receive to maximum benefit. Working with the private sector, the agencies can develop a series of minimum requirements for data production but do not have to commit resources for in-house production of such data. The private sector will make the investment in ensuring that these minimum data requirements are met. Further, all technological improvements and upgrades in the production of such data are borne by the private sector—again preserving agencies funds to meet core mission requirements.

Many federal agencies do not have a similar level of experience the Defense and Intelligence communities possess in leveraging that which the private sector can offer. There oftentimes is a tendency to utilize scarce budget amounts to build entire systems. System development requires updates and modifications—all of which can be sustained by the private sector. The Defense and Intelligence communities have realized they can contract for only the data that their programs require without investing in the overall system themselves. This approach satisfies the need for accurate, updated and timely data with a clear understanding that the data production in the future will continue to improve. Typically, when the private sector continues to invest in technological upgrades, it can offer the data it produces at lower costs because it understands the government will be a market rich environment for the data.

The complexity of vision and mission statement for many civilian agencies, combined with an understaffed and underfunded work force, makes it more critical than ever to engage the commercial sector. The private sector can help these agencies focus on their goals and develop the appropriate technologies, solutions and standards to assist them in accomplishing their mission.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Matthew M. O'Connell, President and Chief Executive Officer, GeoEye, Inc.

Questions submitted by Chairman Mark Udall

Q1. The development of data standards can help facilitate the widespread use of remote sensing data and information. Are you satisfied with the opportunities available to commercial remote sensing companies to help coordinate data formats and standards among Federal Government agencies, academic institutions, and other remote sensing data producers and users? What actions, if any, do you believe would strengthen mechanisms to coordinate the development of data standards?

A1. In response to your question for the record regarding data standards, there are currently several government specific standards we use. While these standards are sufficient for the process and dissemination of commercial imagery, we believe that new standards such as XML-based metadata could exponentially increase the delivery of data. However, the government is very slow to adopt new standards simply because so many of its other systems are legacy-based. We believe our imagery would be more usable to the Department of Defense community if it could be delivered in GeoTIFF/MrSID formats with an XML metadata file. This would expedite the speed in which users could access and receive the data. Nonetheless, we do not believe industry would benefit from any new standards as the government is still attempting to evolve its legacy systems to today's technologies.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Jill Smith, President and Chief Executive Officer, DigitalGlobe, Inc.

Questions submitted by Chairman Mark Udall

Q1. The development of data standards can help facilitate the widespread use of remote sensing data and information. Are you satisfied with the opportunities available to commercial remote sensing companies to help coordinate data formats and standards among Federal Government agencies, academic institutions, and other remote sensing data producers and users? What actions, if any, do you believe would strengthen mechanisms to coordinate the development of data standards?

A1. In response, let me offer that, from DigitalGlobe's perspective, there is currently ample opportunity for industry to participate in the development of remote sensing data formats and standards.

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